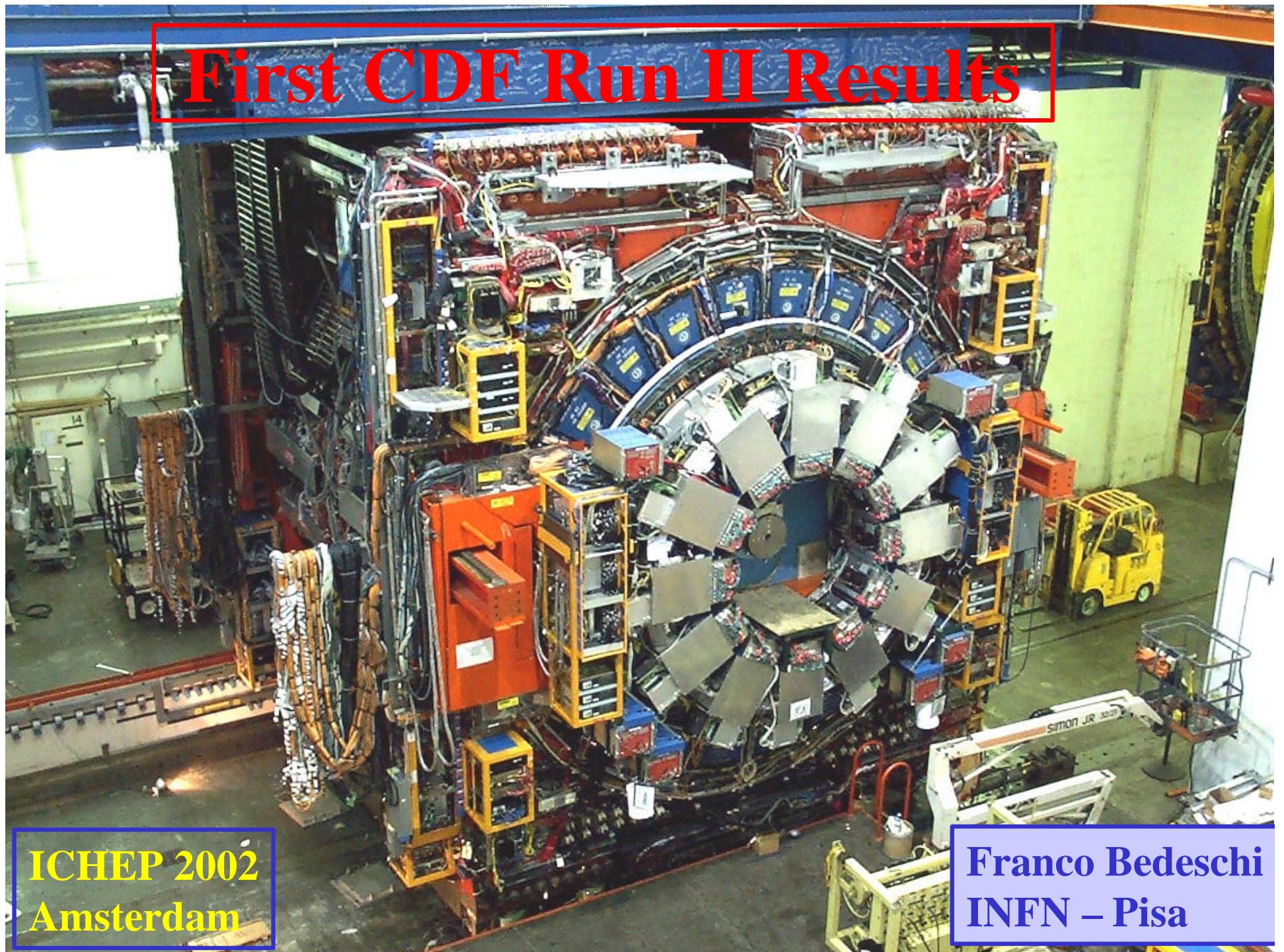


First CDF Run II Results



ICHEP 2002
Amsterdam

Franco Bedeschi
INFN – Pisa



The CDF Collaboration

North America



3 Natl. Labs
28 Universities



1 Universities

Totals

12 countries

58 institutions

581 physicists

Europe



1 Research Lab
6 Universities
1 University



4 Universities



2 Research Labs

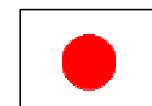


1 University



1 University

Asia



5 Universities
1 Research Lab



1 University



3 Universities

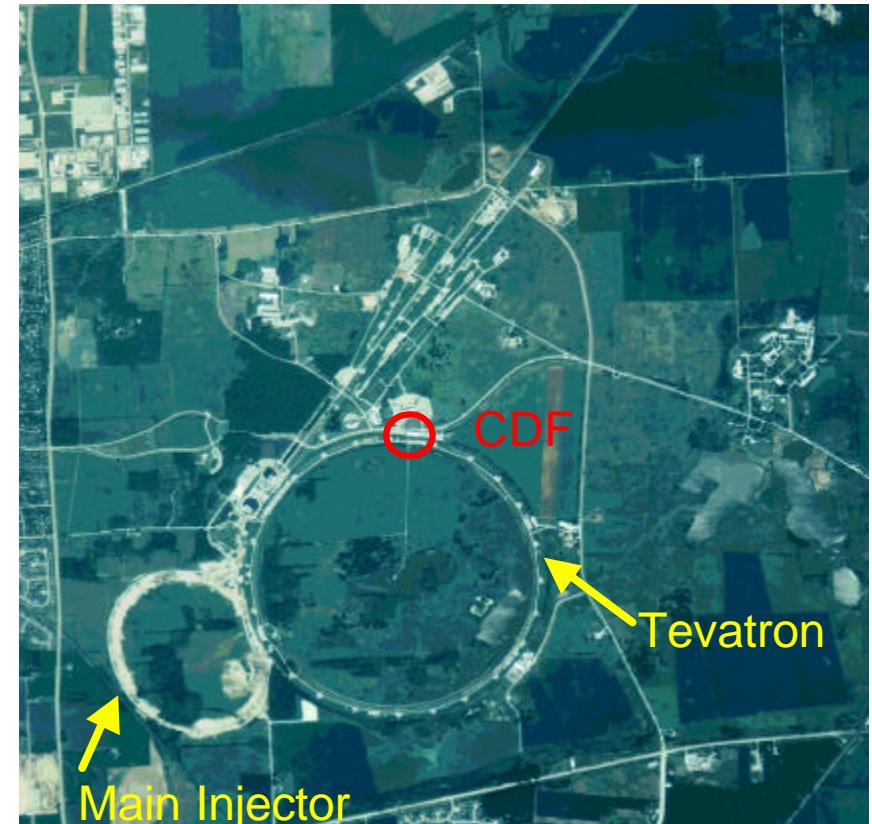


First CDF Run II Results

Outline

- ❖ Status of the Tevatron
- ❖ Status of the CDF detector
- ❖ First results with Run II data
- ❖ Outlook and conclusions

Franco Bedeschi
CDF Collaboration
INFN - Pisa





Tevatron status

❖ Tevatron operations started in March 2001

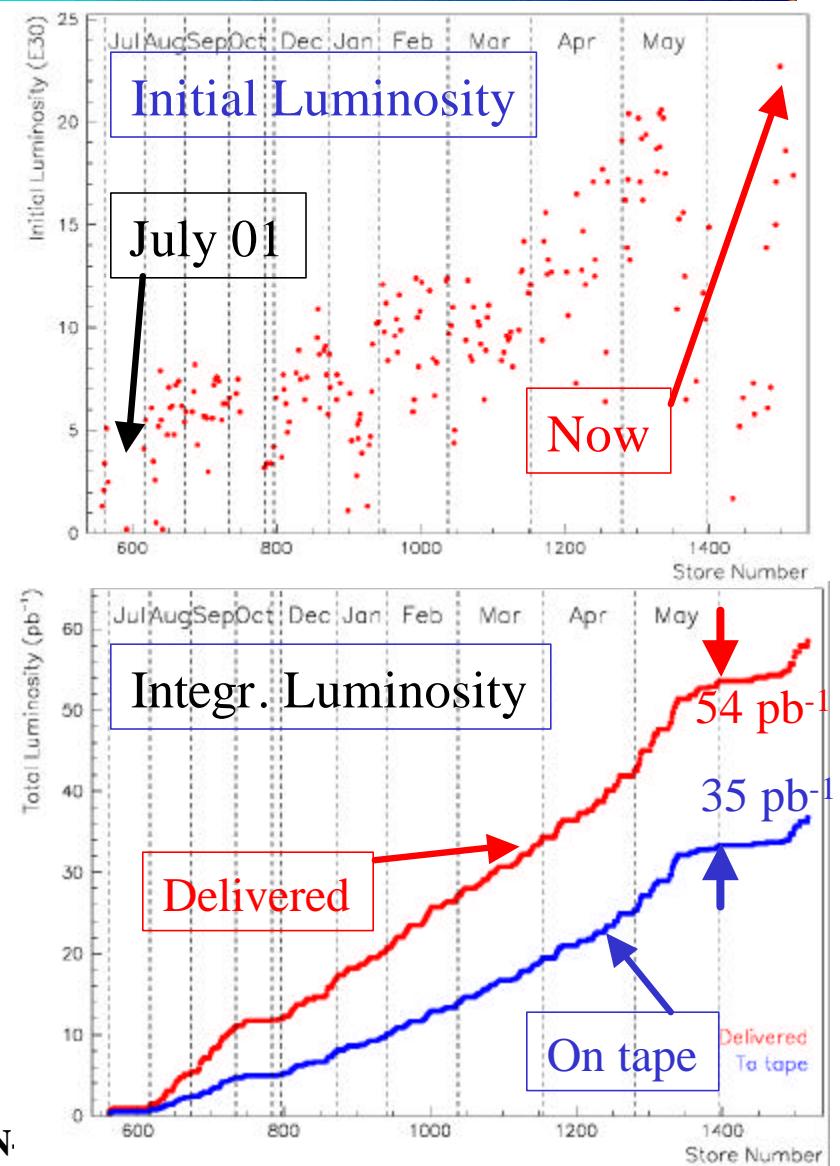
➤ Luminosity goals for run 2a:

- $5-8 \times 10^{31}$ cm $^{-2}$ sec $^{-1}$ w/o Recycler
- 2×10^{32} cm $^{-2}$ sec $^{-1}$ with Recycler

➤ Achieved:

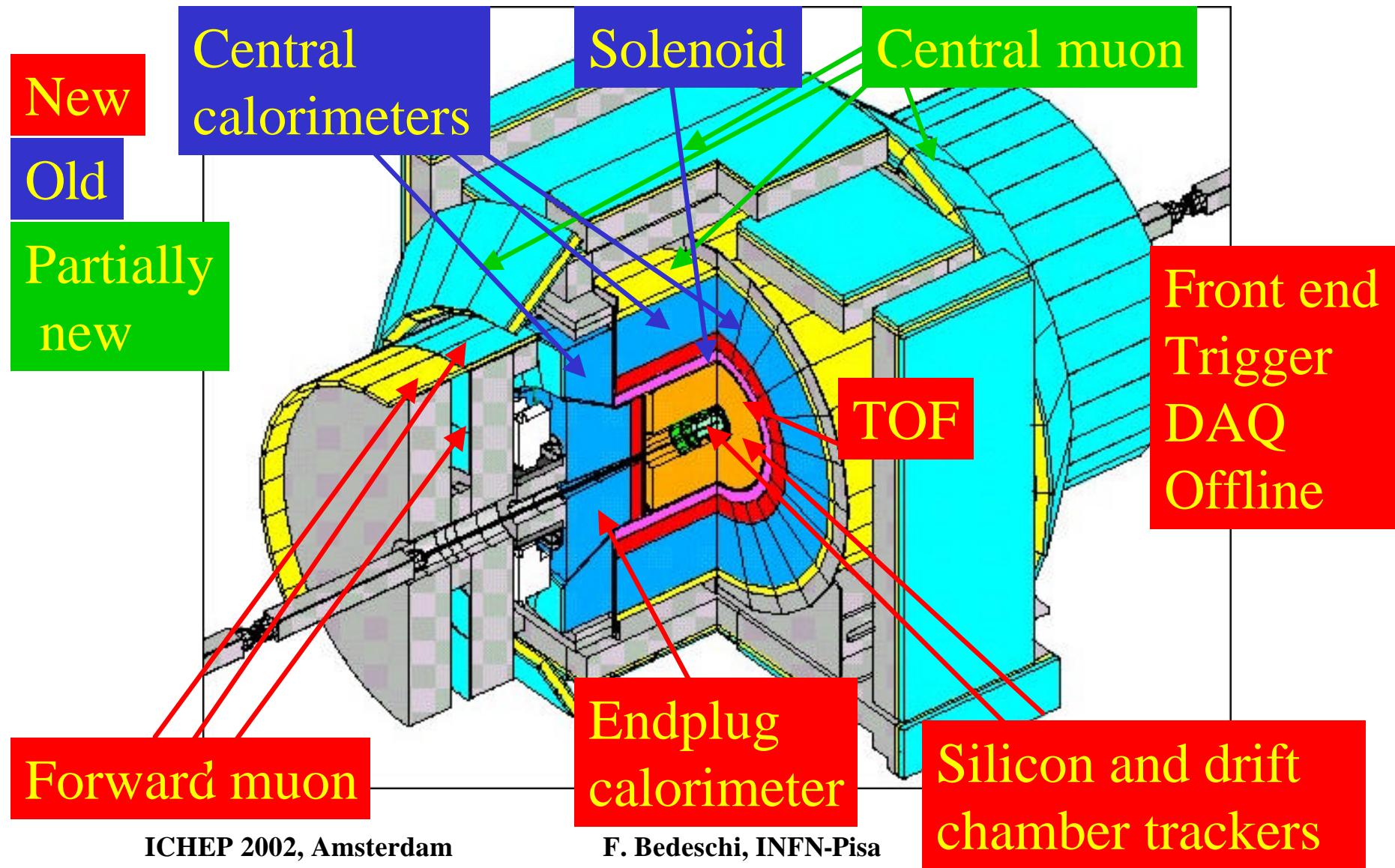
- 2.2×10^{31} cm $^{-2}$ sec $^{-1}$ in July '02
- Now recovered from June shutdown to improve p-bar cooling
- 54 pb^{-1} delivered until early June
 - ◆ 35 pb^{-1} are on tape
 - ◆ $10 - 20 \text{ pb}^{-1}$ used for analyses shown at this conference ([details](#))

[plans](#)





The Upgraded CDF Detector





The Upgraded CDF Detector

- ❖ Major qualitative improvements over Run 1 detector:

- Whole detector can run up to 132 nsec interbunch
- New full coverage 7-8 layer 3-D Si-tracking up to $|\eta| \sim 2$
- New faster drift chamber with 96 layers
- New TOF system
- New plug calorimeter
- New forward muon system
- New track trigger at Level 1 (XFT)
- New impact parameter trigger at Level 2 (SVT)

} Forward region restructured

- ❖ All systems working well

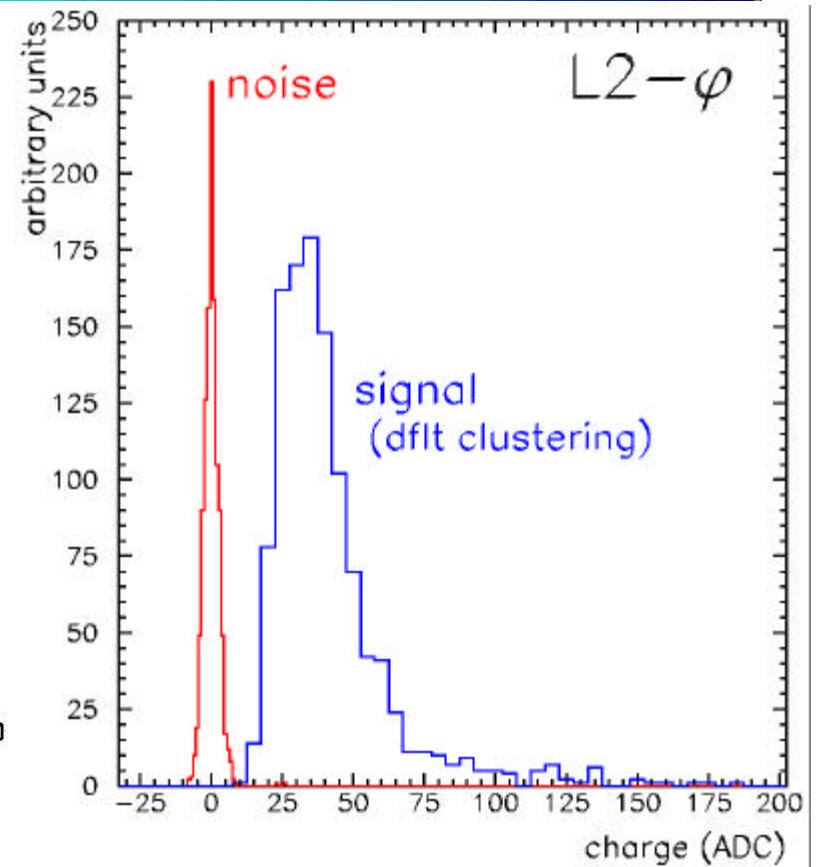
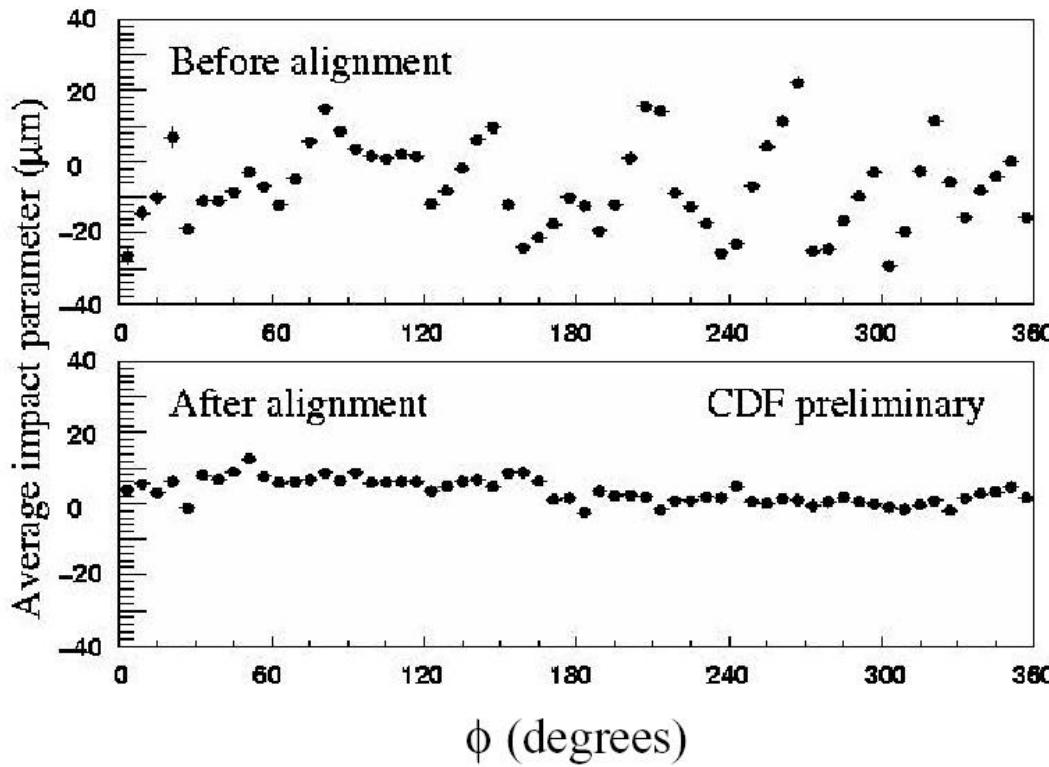
- Silicon and L2 took longer to commission



Detector Performance

❖ Silicon detectors:

- Typical S/N ~ 12
- Alignment in R- ϕ good
- R-z ongoing



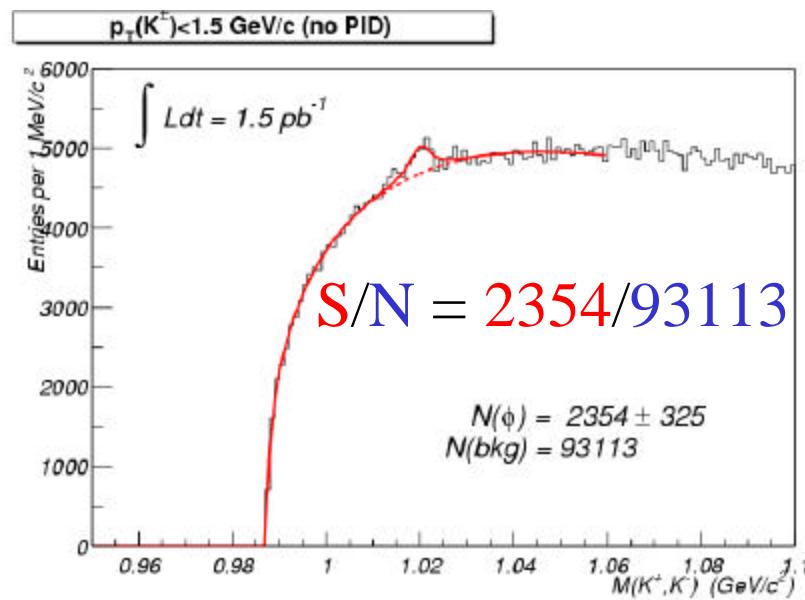
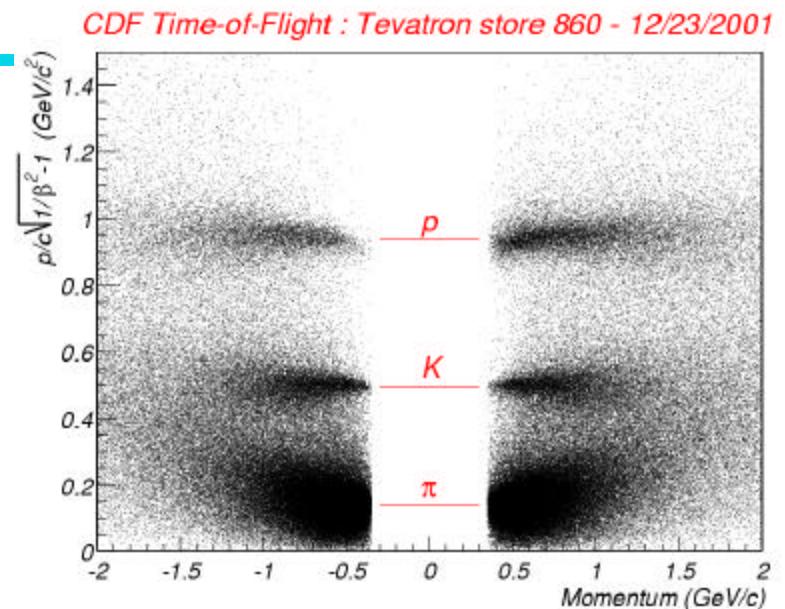
sa

[Details](#)

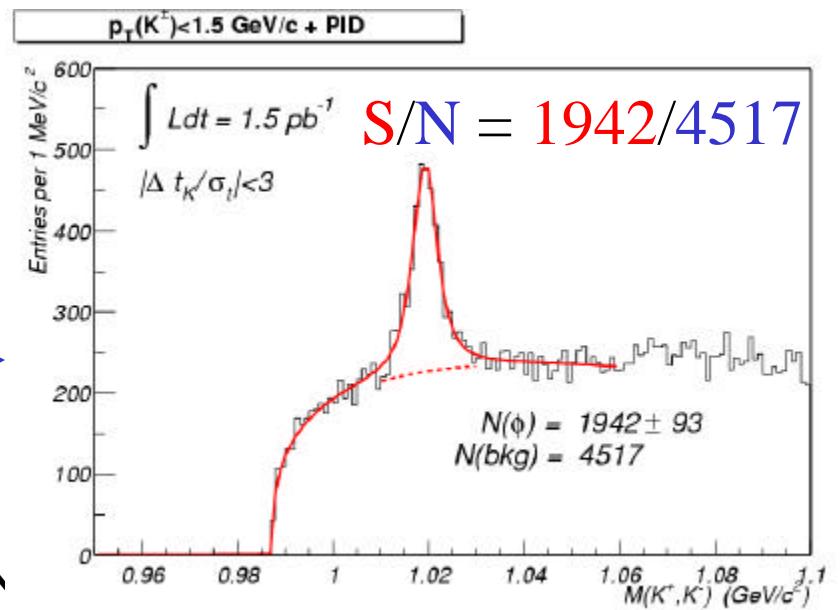


Detector Performance

- ❖ TOF resolution within 10 –20% of design value
 - Improving calibrations and corrections

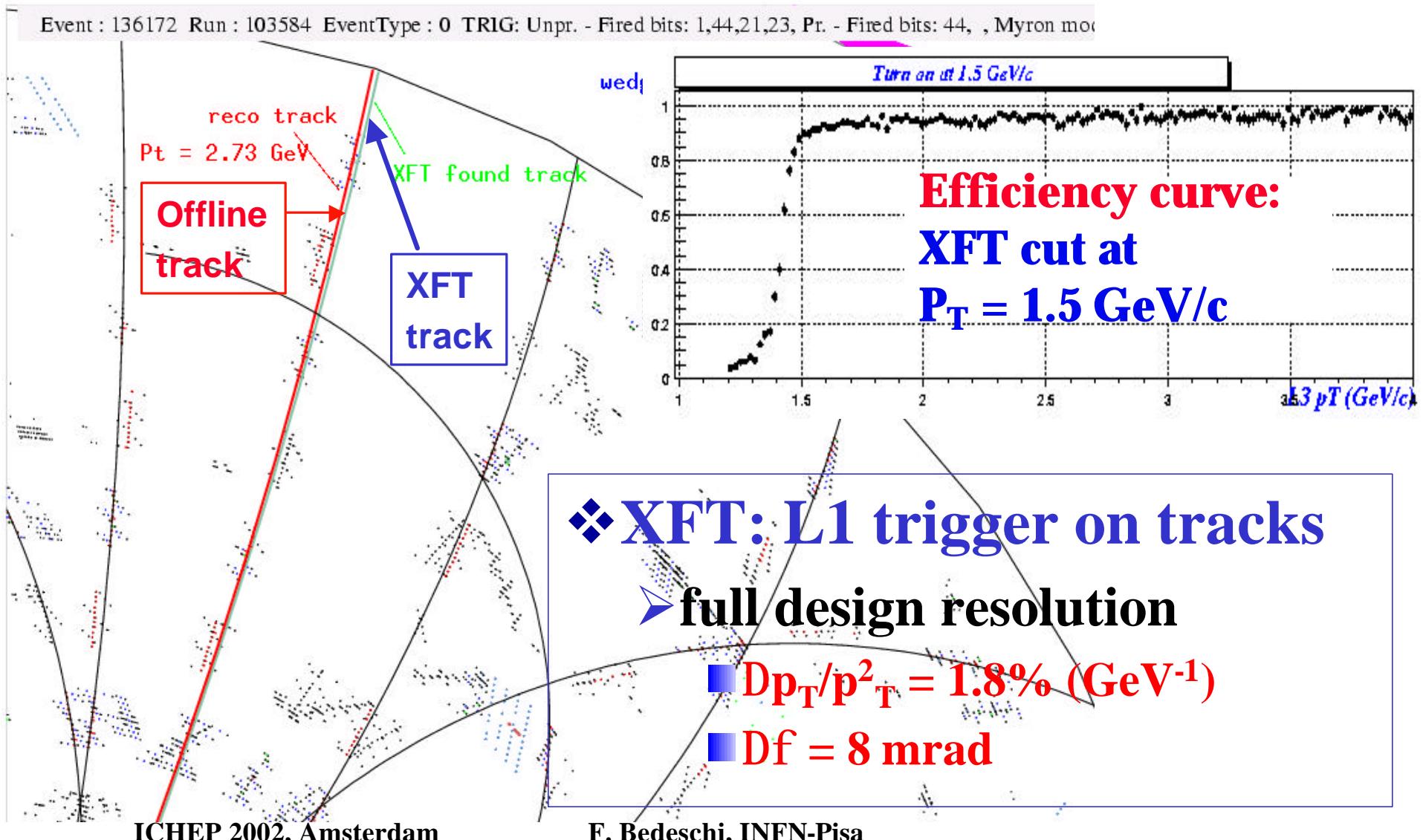


TOF
→
deschi, II





Detector Performance

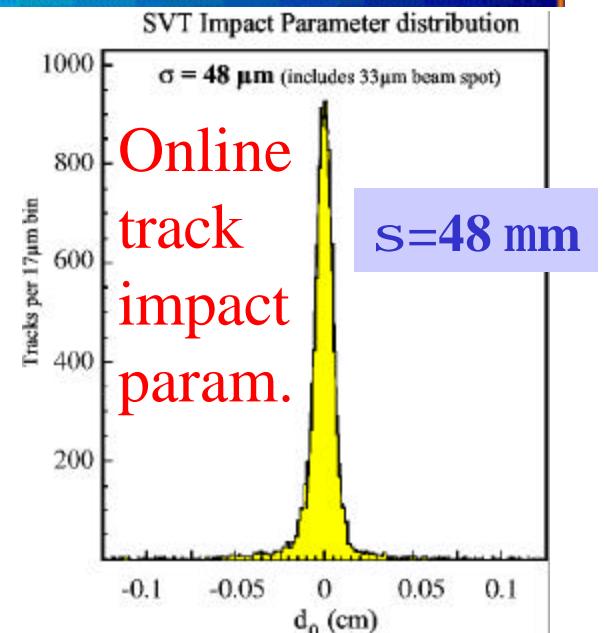




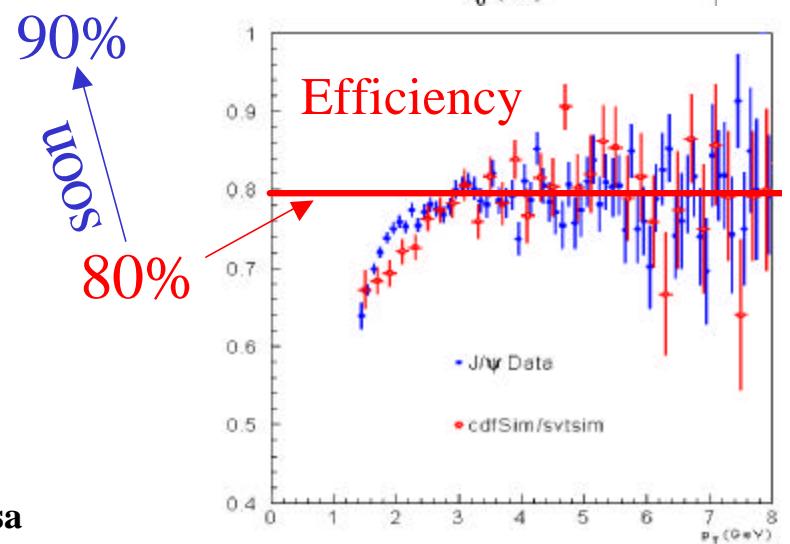
Detector Performance



8 VME crates
Find tracks in
Si in 20 μs
with offline
accuracy



- ❖ Secondary VerTex L2 trigger
 - Online fit of primary Vtx
 - Beam tilt aligned
 - D resolution as planned
 - **48 mm** (33 mm beam spot transverse size)





Physics with CDF-II

- ❖ Use data to understand the new detector:
 - energy scales in calorimeter and tracking systems
 - detector calibrations and resolutions
 - tune Monte Carlo to data
- ❖ Use data to do **physics analyses**
 - Real measurement beyond PR plots
 - Quality of standard signatures
 - Rates of basic physics signals
 - **Surprisingly some results are already of relevance in spite of the limited statistics**
 - Several CDF presentations made in the parallel sessions [list](#)
 - In the following brief/incomplete summary of a lot of work

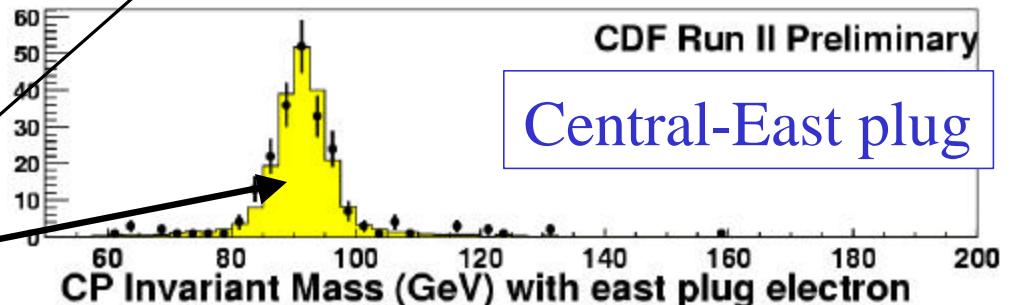
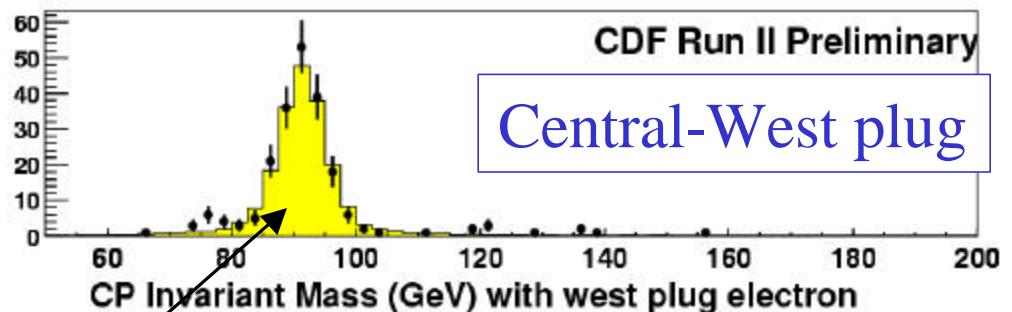
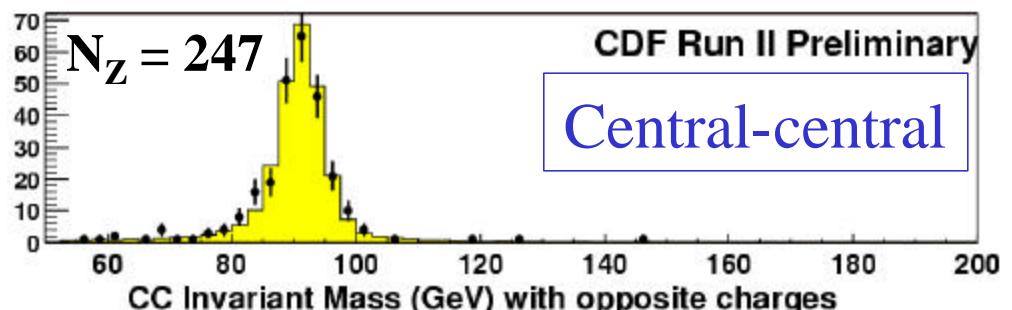


EM Calorimeter scale

- ❖ 638 $Z \rightarrow e^+e^-$ in 10 pb^{-1}
 - $\sigma(M) \sim 4 \text{ GeV}$ [FB asymmetry](#)

- ❖ Check **Z mass** in data and simulation after corrections
 - Central region:
 - Mean: +1.2% data, -0.6% sim.
 - Resolution: +2% simulation
 - Forward region (Plug):
 - Mean: +10/6.6% data, +2.0% simulation
 - Resolution: +4% simulation

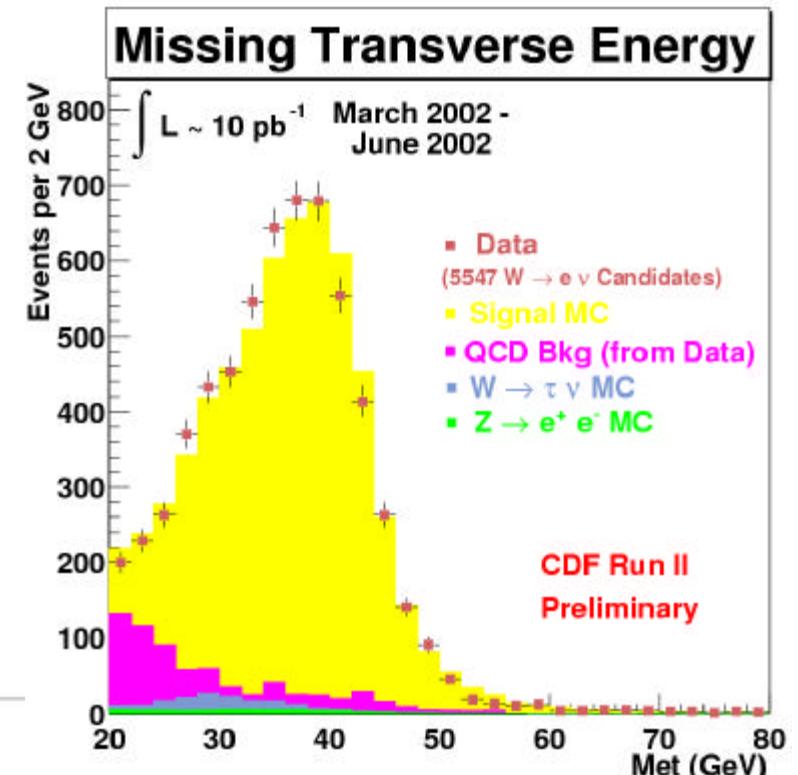
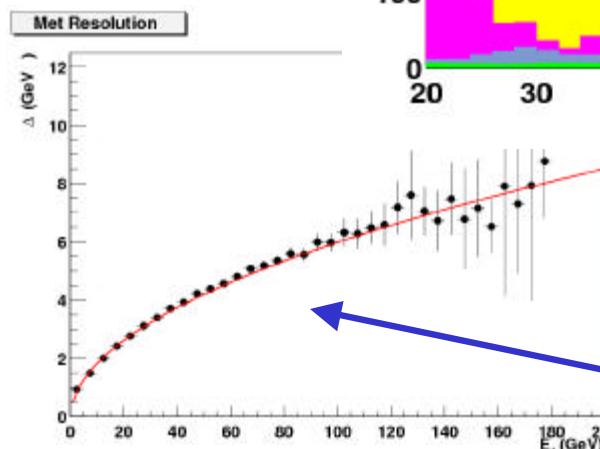
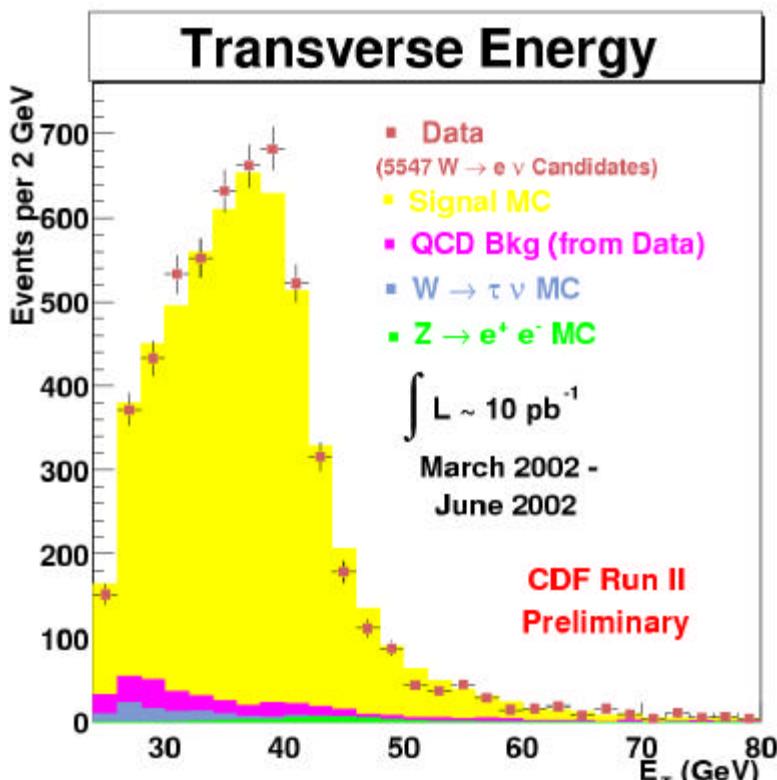
$N_Z (W+E) = 391$



Measurements with high E_T e^\pm

- ❖ Good modeling of observed $W \rightarrow e\nu$ distributions

[Selection details](#)



MET resolution from MB data consistent with Run 1



Measurements with high $E_T e^\pm$

❖ W cross section:

- $\sigma_W^* \text{BR}(W \rightarrow e\nu) (\text{nb}) = 2.60 \pm 0.07_{\text{stat}} \pm 0.11_{\text{syst}} \pm 0.26_{\text{lum}}$
- Consistent with Run 1 results rescaled for higher energy:
 $2.72 \pm 0.02_{\text{stat}} \pm 0.08_{\text{syst}} \pm 0.09_{\text{lum}}$
 (use Sterling et al. NNLO predictions)

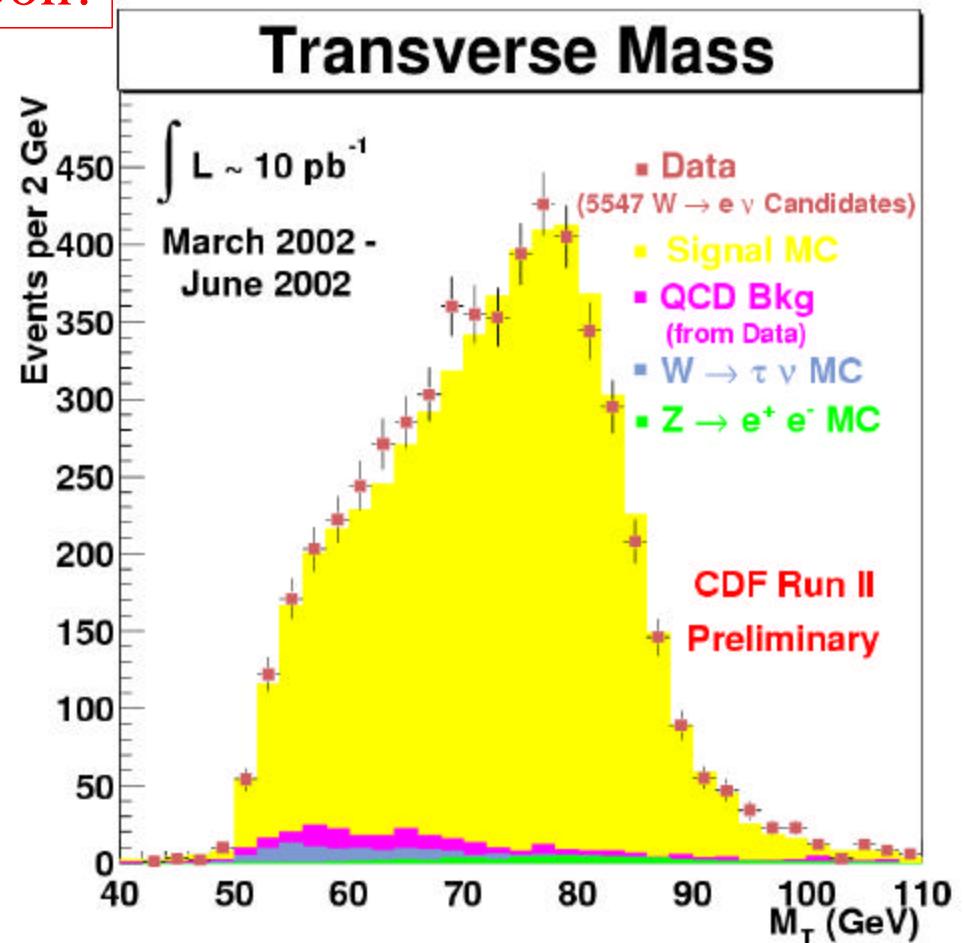
0.16 soon!

Nr. Candidates:

- 5547 in 10 pb^{-1}

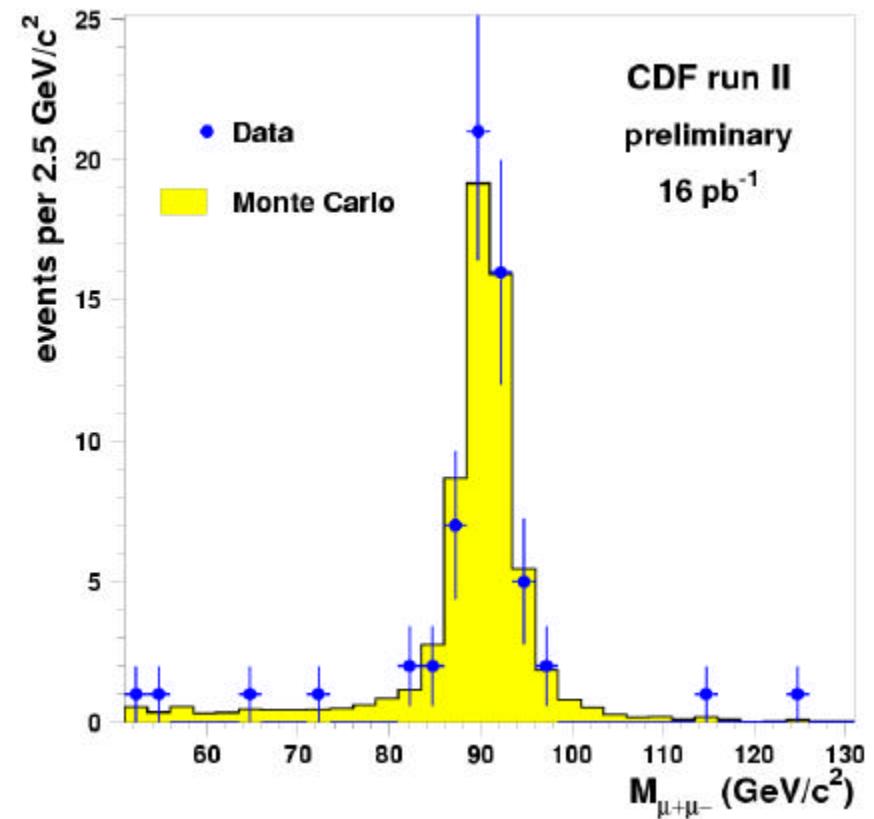
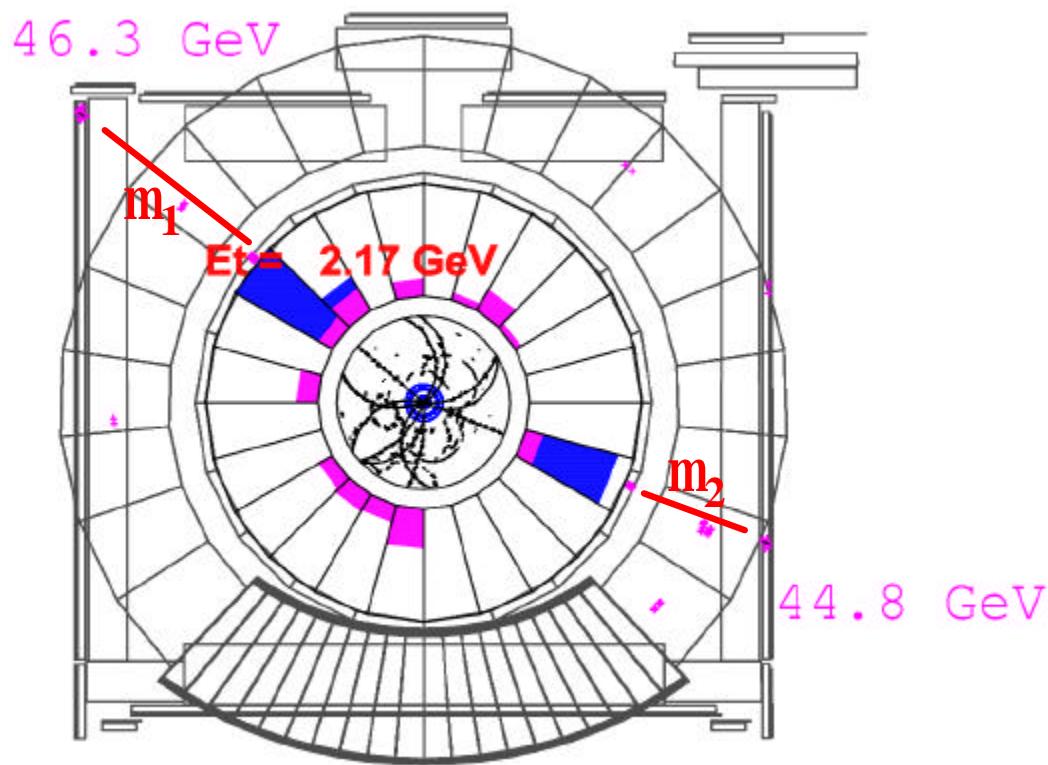
Background:

- QCD: $260 \pm 34 \pm 78$
- $Z \rightarrow ee$: $54 \pm 2 \pm 3$
- $W \rightarrow tn$: $95 \pm 6 \pm 1$



Measurements with high $E_T \mu^\pm$

- ❖ Clear evidence of $Z \rightarrow m^+m^-$
 - Signal shown for OS muons detected in both inner and outer muon chambers



- 57 candidate events in $66 < M_{\text{inv}} < 116$ range
- $N_Z = 53.2 \pm 7.5 \pm 2.7$

Measurements with high $E_T \mu^\pm$

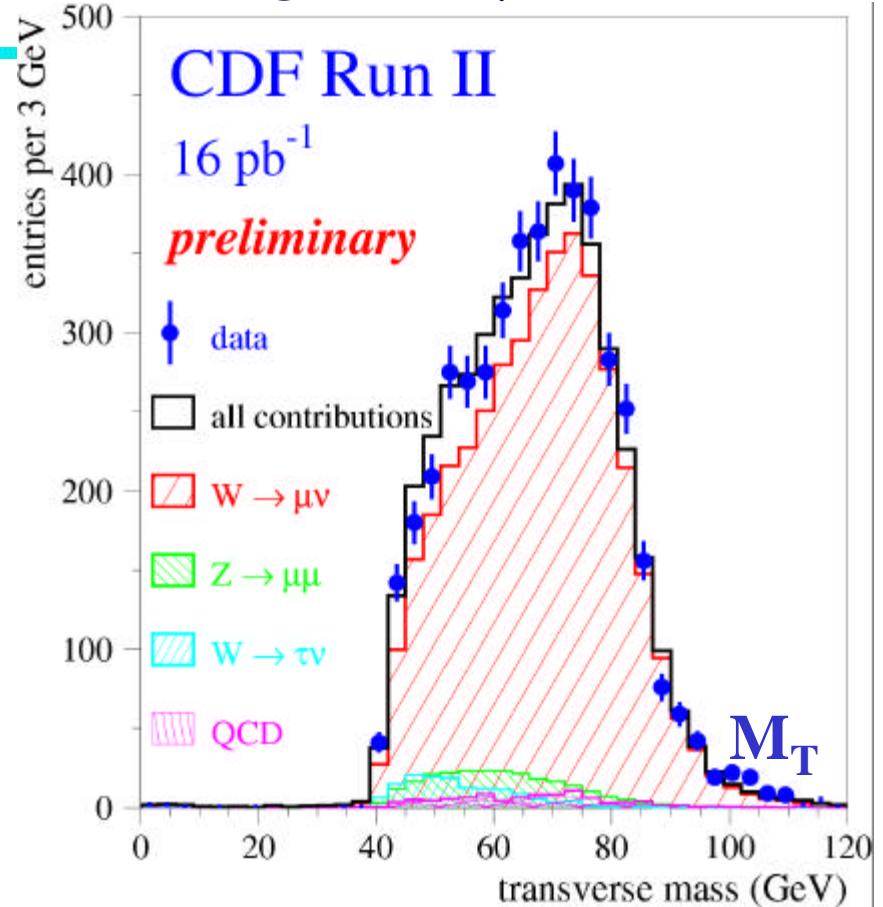
- ❖ W cross section: [Details](#)
 - $\sigma_W^* \text{BR}(W \rightarrow \mu\nu)$ (nb) = $2.70 \pm 0.04_{\text{stat}} \pm 0.19_{\text{syst}} \pm 0.26_{\text{lum}}$
 - Consistent with Run 1 results rescaled for higher energy: $2.41 \pm 0.08_{\text{stat}} \pm 0.15_{\text{syst}} \pm 0.16_{\text{lum}}$ (use Sterling et al. NNLO predictions)

Nr. Candidates:

- **4561 in 16 pb^{-1}**

Background:

- QCD: 104 ± 53
- Cosmics: 73 ± 30
- $Z \rightarrow mm$: 247 ± 13
- $W \rightarrow tn$: 145 ± 10



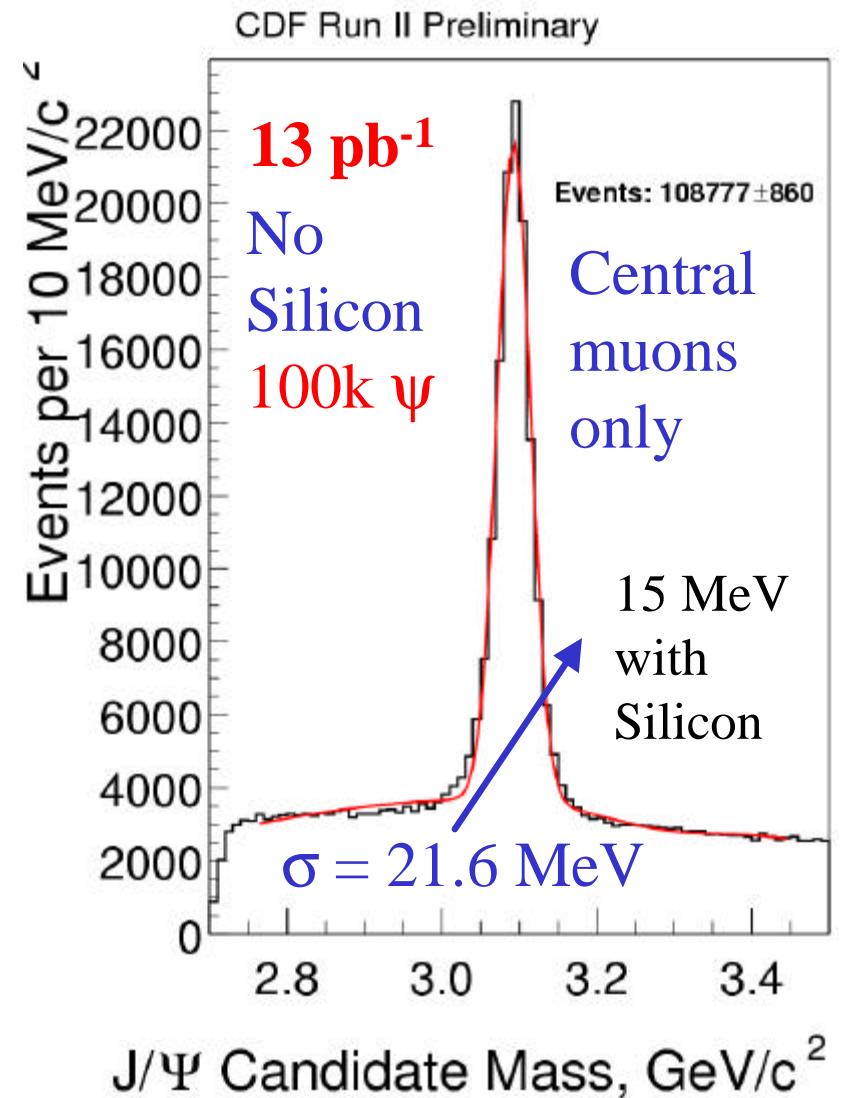
❖ $R = S(W \rightarrow mn)/S(Z \rightarrow mm) =$

$$13.66 \pm 1.94_{\text{stat}} \pm 1.12_{\text{syst}}$$

- Consistent with Run 1 results

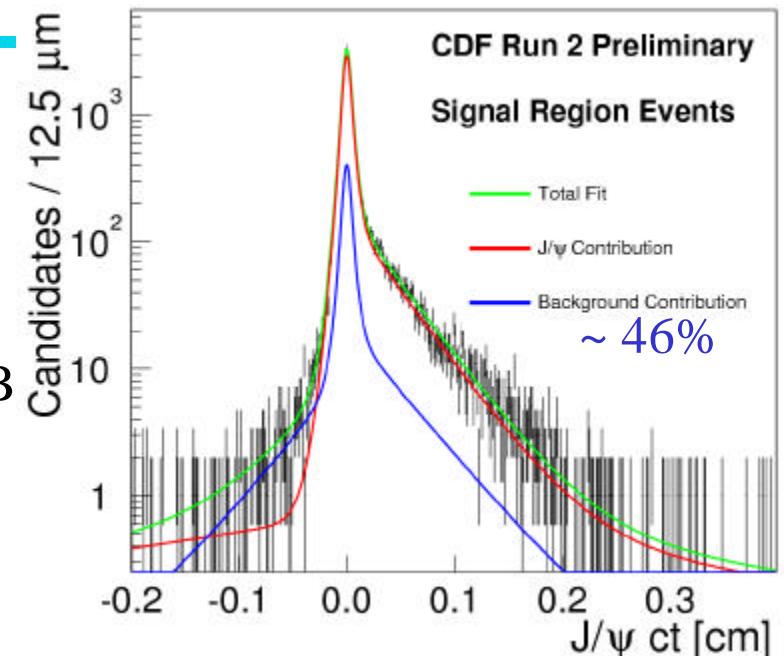
Measurements with low $\text{E}_T \mu^\pm$

- ❖ ψ trigger improved
 - $p_T^\mu > 2.0 \rightarrow 1.5 \text{ GeV}$
 - $\Delta\phi > 5^\circ \rightarrow 2.5^\circ$
- ❖ Observed ψ rates are consistent with expected increase due the lowering of the thresholds

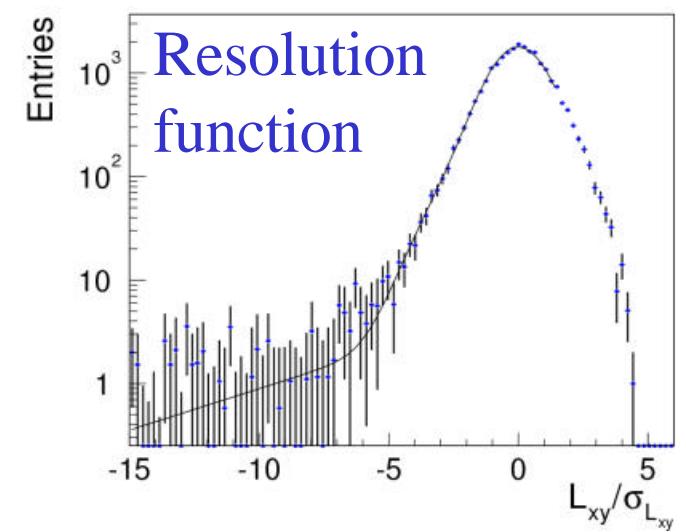


Measurements with low $E_T \mu^\pm$

- ❖ Inclusive B lifetime with ψ 's
 - Fit $\text{pseudo-}ct = L_{xy}^\psi * F_{\text{MC}} * M^\psi / p_T^\psi$ distribution
 - Output: b lifetime, fraction of ψ from B
 - ◆ $ct = 458 \pm 10 \text{ stat.} \pm 11 \text{ syst. } \mu\text{m}$
(PDG: $469 \pm 4 \mu\text{m}$)
 - ◆ ψ from B = 17% ($p_T^\psi > 4 \text{ GeV}$)



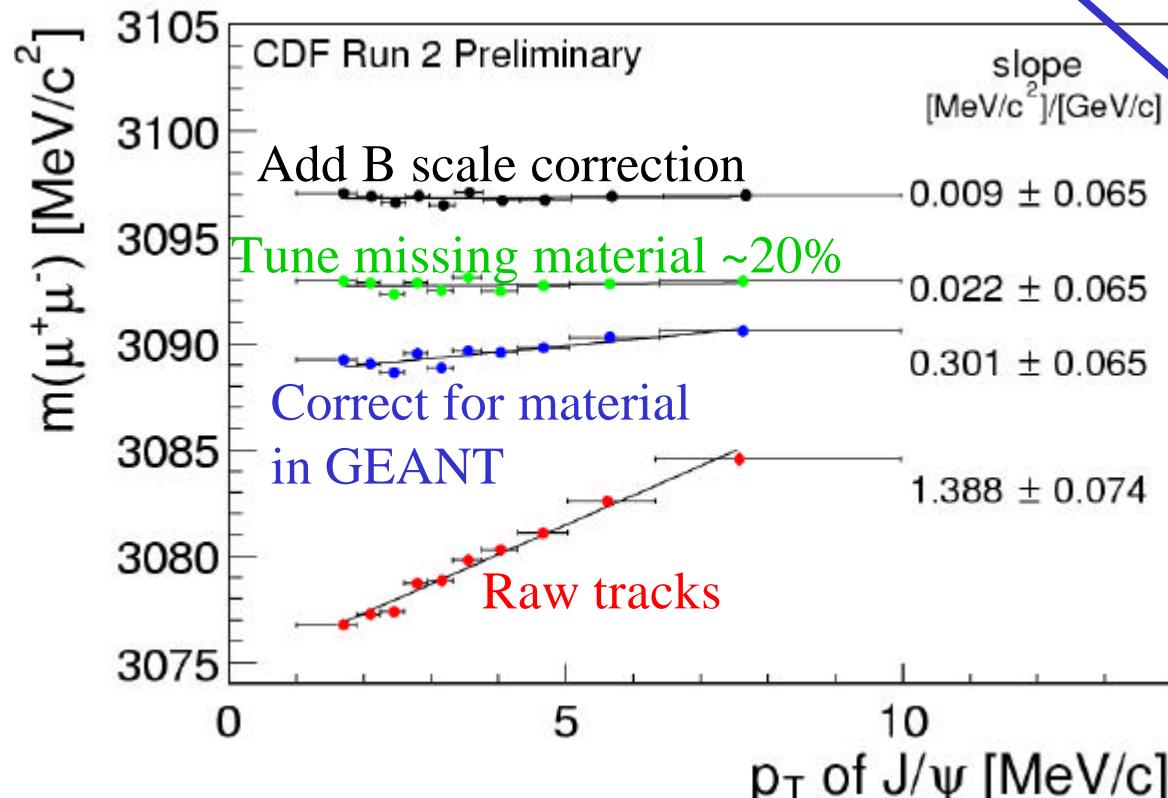
- ❖ Resolution function from large prompt component
 - R = narrow + wide Gaussian (19%) + exponential tails (1.2%)
 - Scale factor on error returned from vertex fit **1.069**





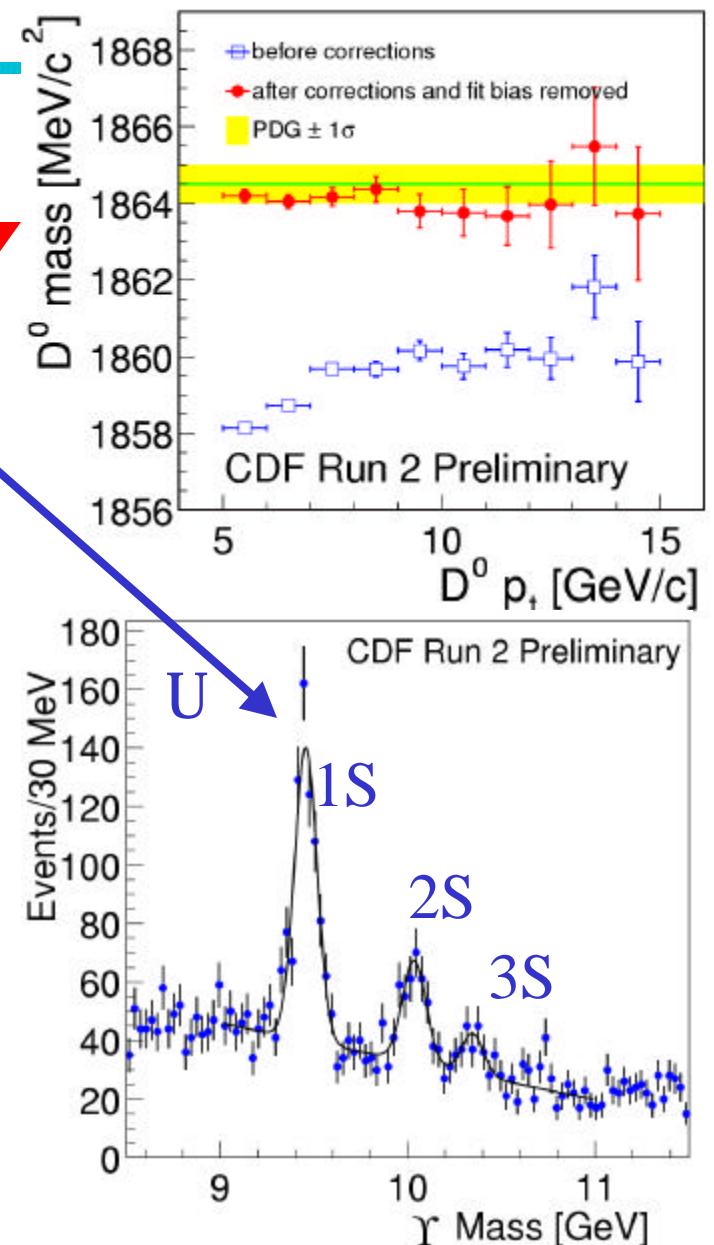
Measurements with low E_T μ^\pm

- ❖ Use ψ 's to understand E-loss and B-field corrections
- ❖ Check with other known signals



ICHEP 2002, Amsterdam

F. Bedeschi, INFN-Pisa



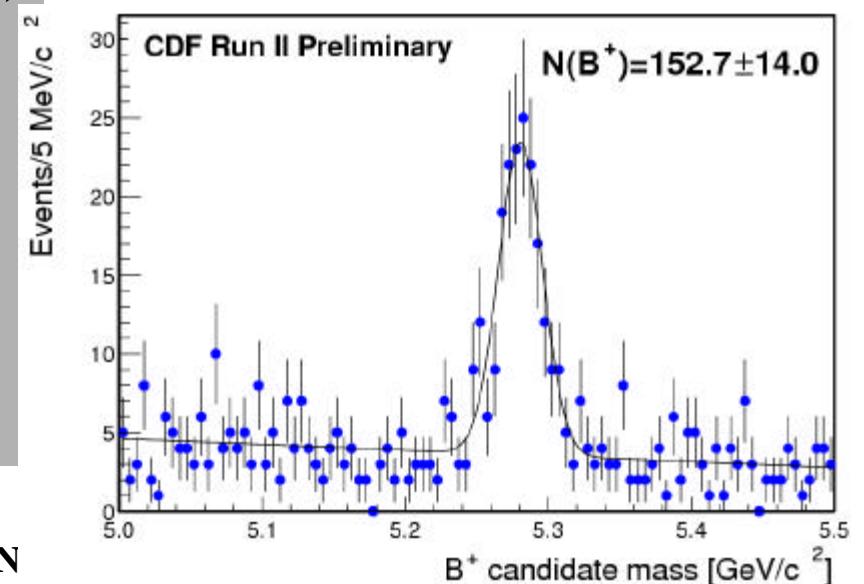
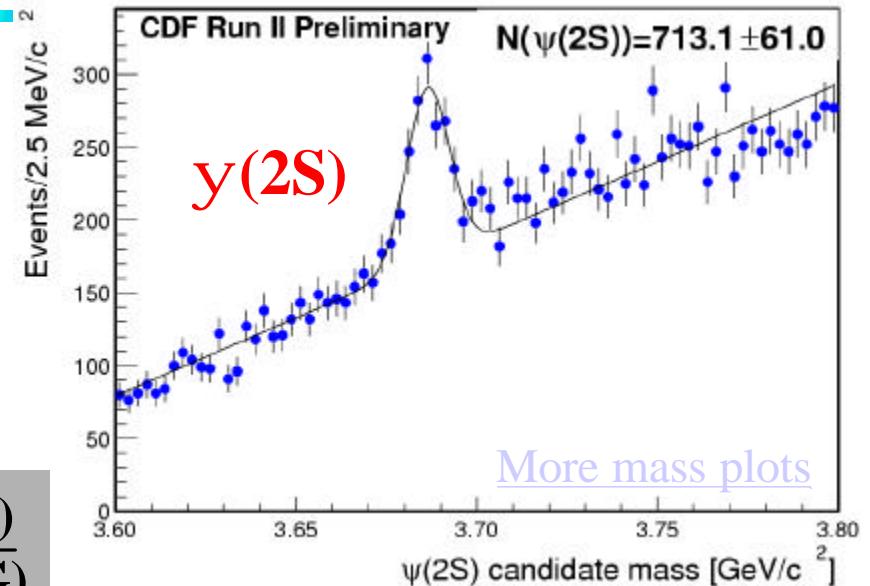


Measurements with low Et μ^\pm

❖ B masses: semi-leptonic B

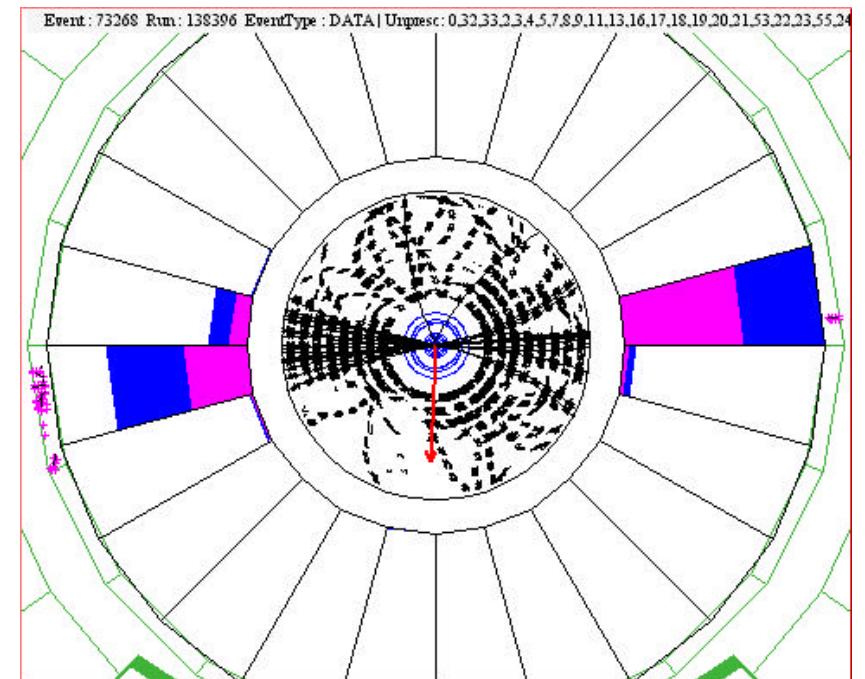
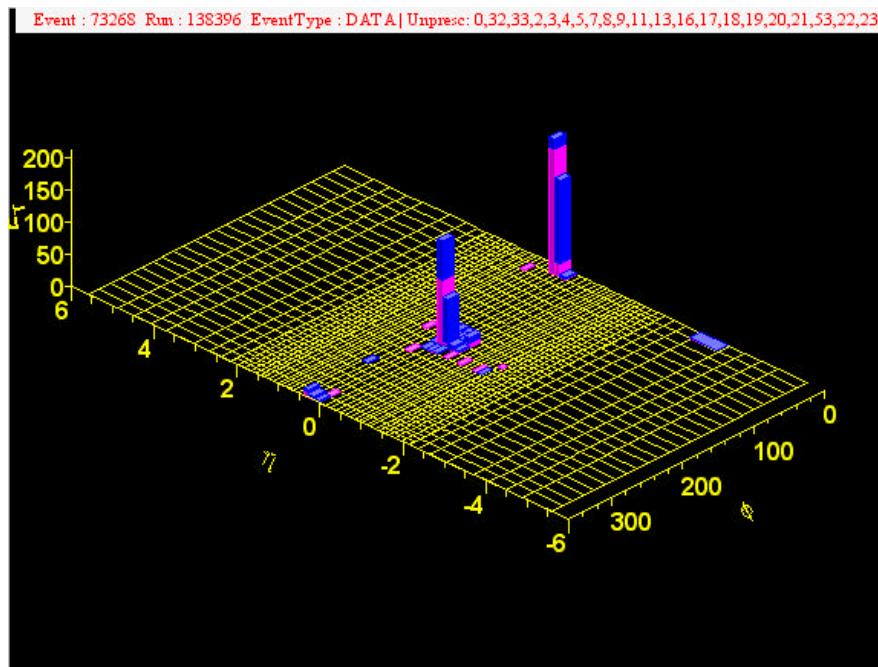
- $\psi(2S) \rightarrow J/\psi \pi^+ \pi^-$ (control)
- $B_u \rightarrow J/\psi K^+$ lifetime
- $B_d \rightarrow J/\psi K^{0*}$ ($K^{0*} \rightarrow K^+ \pi^-$)
- $B_s \rightarrow J/\psi \phi$ ($\phi \rightarrow K^+ K^-$)

	CDF 2002	DPDG/S	$\frac{s(\text{CDF})}{s(\text{PDG})}$
$\psi(2S)$	3686.43 ± 0.54	0.86	6.00
B_u	$5280.60 \pm 1.70 \pm 1.1$	0.77	4.05
B_d	$5279.80 \pm 1.90 \pm 1.4$	0.17	4.72
B_s	$5360.30 \pm 3.80 \pm$ 2.10 2.90	-1.81	1.90



Measurements with jets

- ❖ Raw Et only:
 - Jet 1: ET = 403 GeV
 - Jet 2: ET = 322 GeV

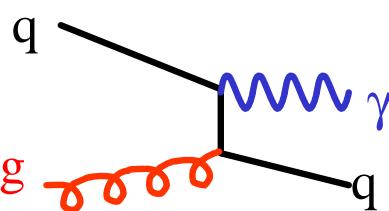




Hadronic Energy Scale

- ❖ Use J/ψ muons to measure MIP in hadron calorimeters

➤ $(\text{Run II})/(\text{Run 1}) = 0.96 \pm 0.05$



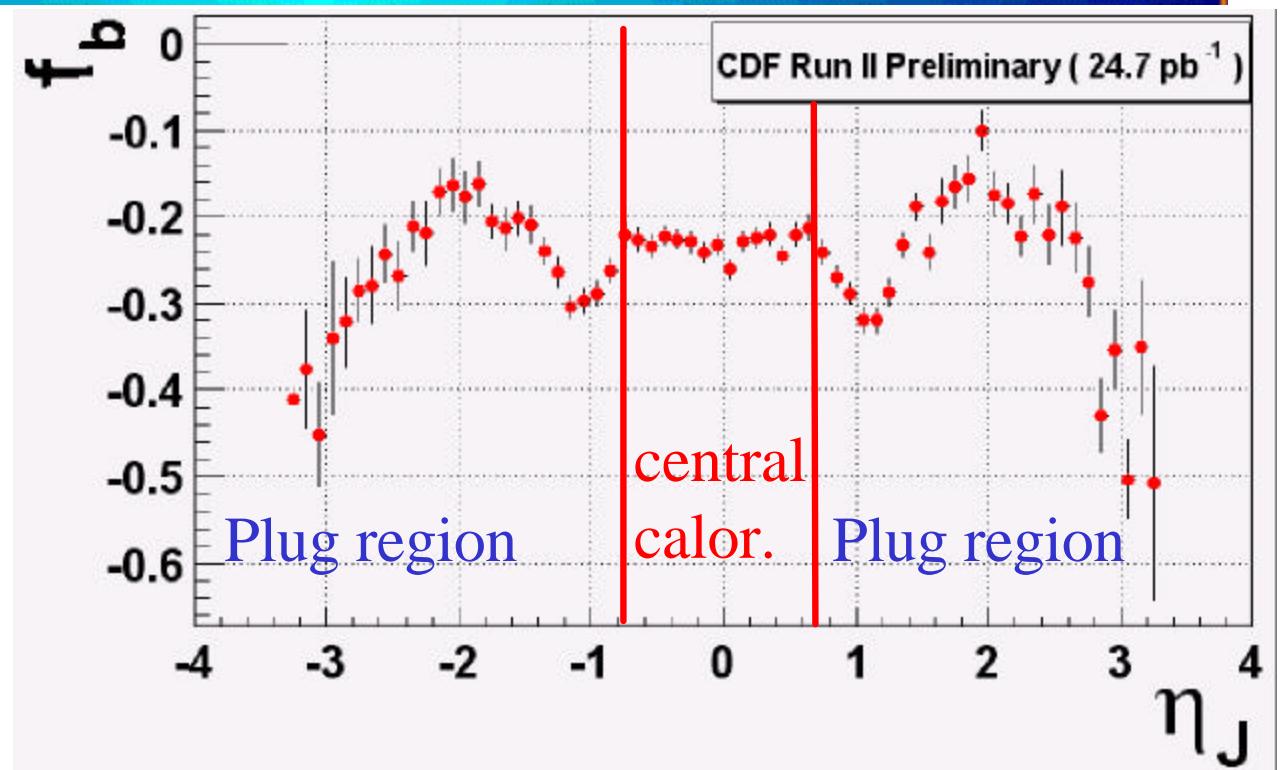
- ❖ Gamma-jet balancing

➤ $f_b = (p_T^{\text{jet}} - p_T^\gamma)/p_T^\gamma$

■ Run Ib (central):

■ Run II (central):

- Plug region corrections in progress



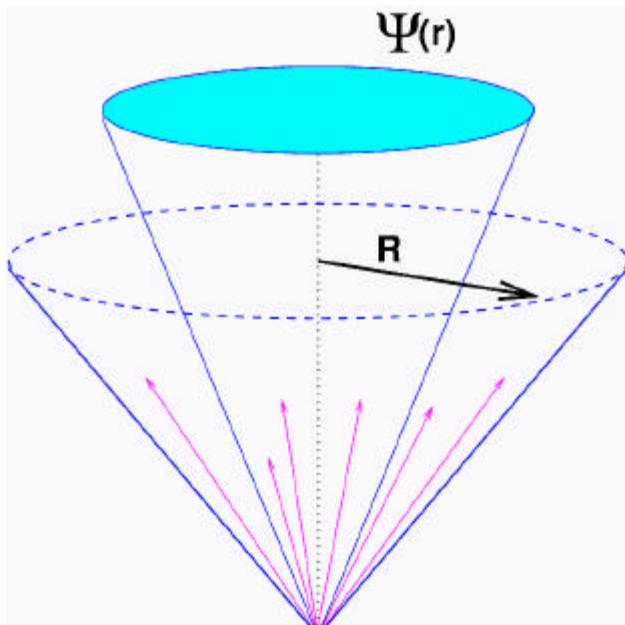
$$\left. \begin{array}{l} f_b = -0.1980 \pm 0.0017 \\ f_b = -0.2379 \pm 0.0028 \end{array} \right\}$$

$\Delta f_b = (4.0 \pm 0.4)\%$

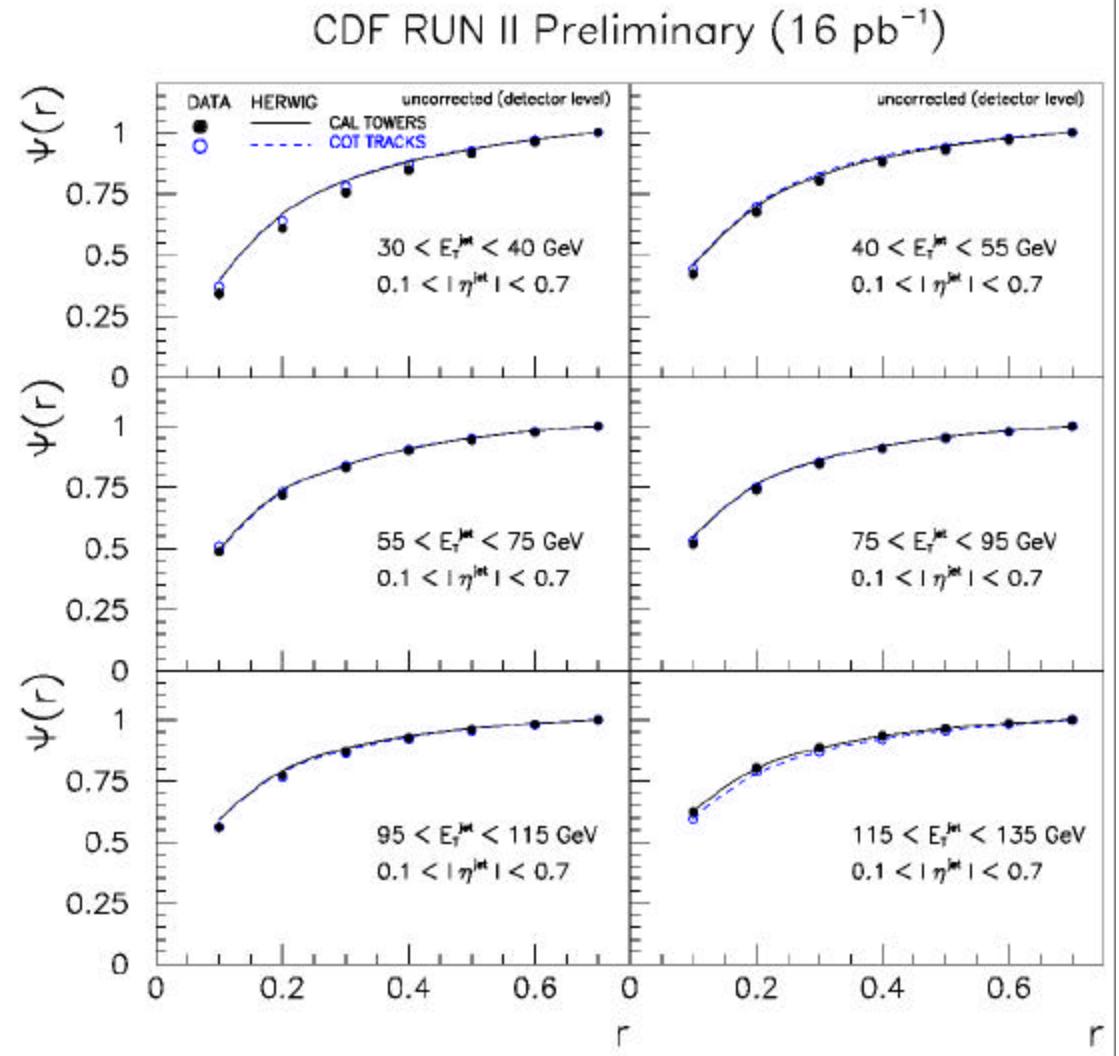
Measurements with jets

❖ Jet shapes:

- Narrower at higher E_T
- Calorimeter and tracking consistent
- Herwig modeling OK



ICHEP 2002, Amsterdam



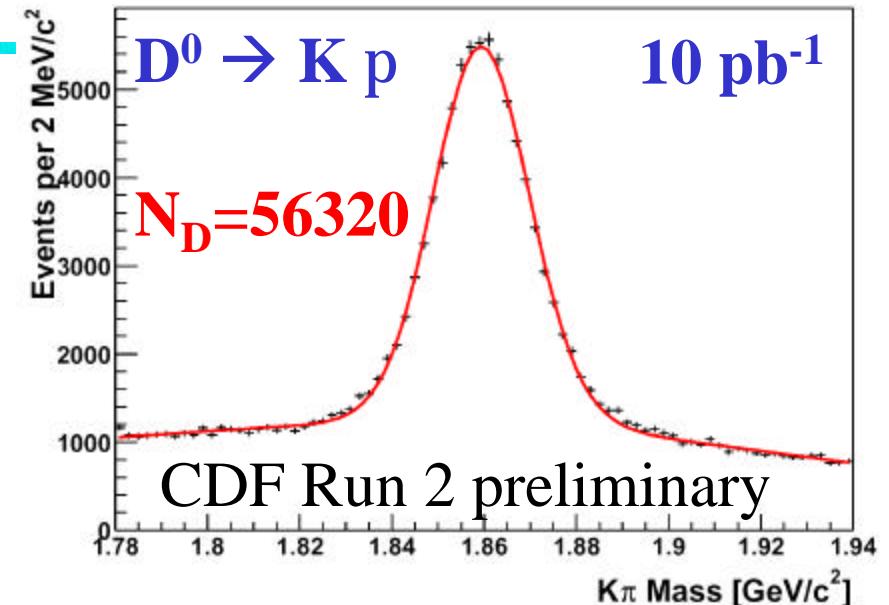
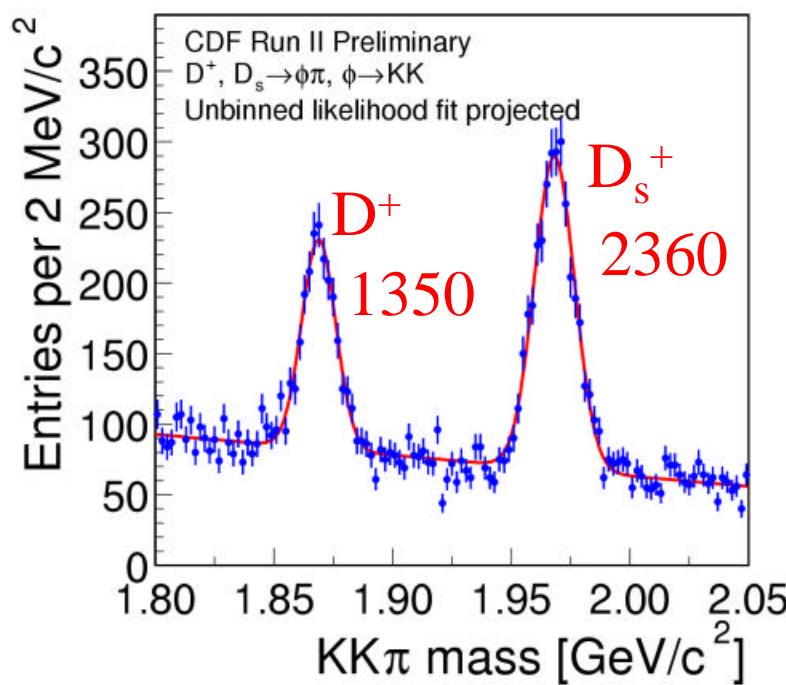
F. Bedeschi, INFN-Pisa

16 pb⁻¹ used for this study



Measurements with hadronic b triggers

- ❖ L2 trigger on 2 tracks:
 - $\text{pt} > 2 \text{ GeV}$
 - $|\text{D}| > 100 \mu\text{m}$ (2 body)
 - $|\text{D}| > 120 \mu\text{m}$ (multibody)
- ❖ Swamped by D mesons!
 - But see B's as well....

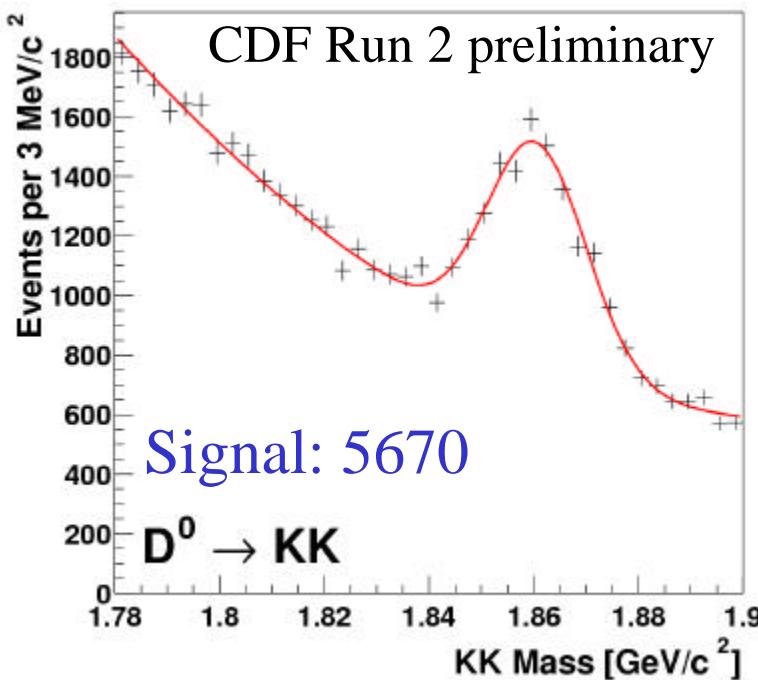


- ❖ $D_s^\pm - D^\pm$ mass difference
 - Both $D \rightarrow \phi\pi$ ($\phi \rightarrow KK$)
 - $\Delta m = 99.28 \pm 0.43 \pm 0.27 \text{ MeV}$
 - PDG: $99.2 \pm 0.5 \text{ MeV}$
 - Systematics dominated by background modeling

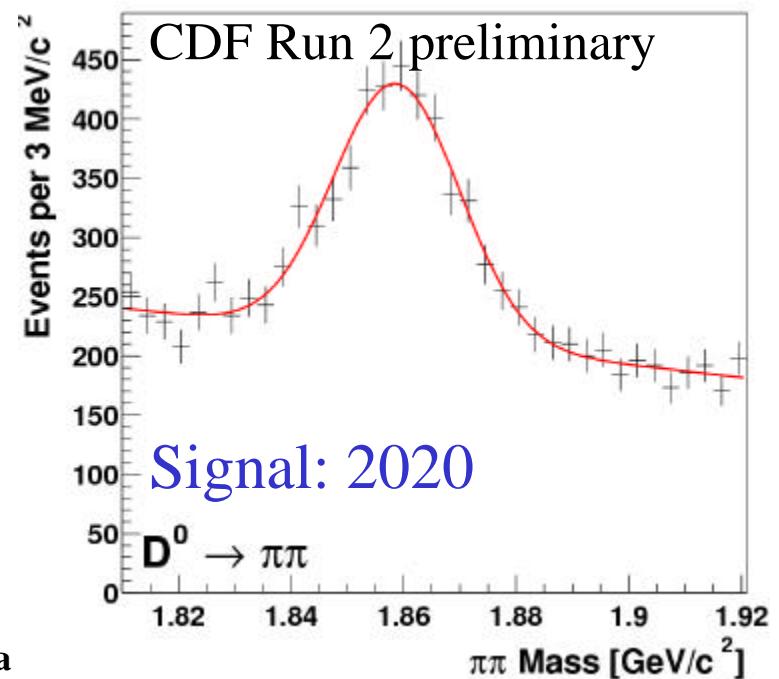


Measurements with hadronic b triggers

- ❖ Measure ratios of CKM suppressed decays
 - $\Gamma(D \rightarrow KK)/\Gamma(D \rightarrow K\pi) = (11.17 \pm 0.48 \pm 0.98)\%$ (PDG: 10.84 ± 0.45)
 - Main systematics (8%): background modeling
 - $\Gamma(D \rightarrow \pi\pi)/\Gamma(D \rightarrow K\pi) = (3.37 \pm 0.20 \pm 0.16)\%$ (PDG: 3.76 ± 0.20)
 - Main systematics (4%): relative acceptance



F. Bedeschi, INFN-Pisa





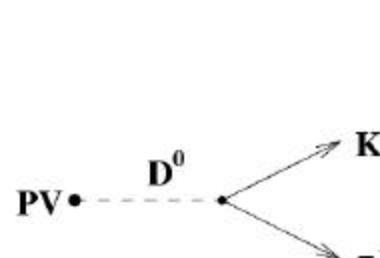
Measurements with hadronic b triggers

❖ D mesons:

- What fraction from B?
- D⁰: 16.4-23.1%
- D^{*+}: 11.4-20.0%
- D⁺: 11.3-17.3%
- D_s⁺: 34.8-37.8%

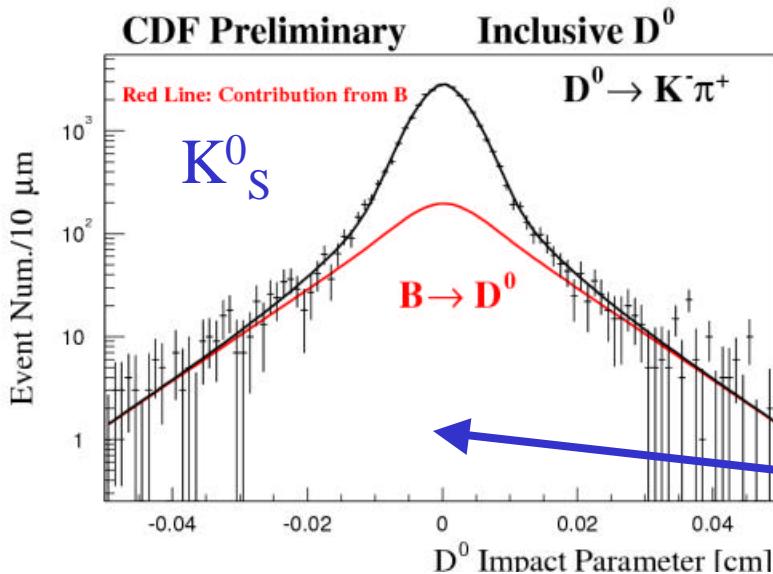
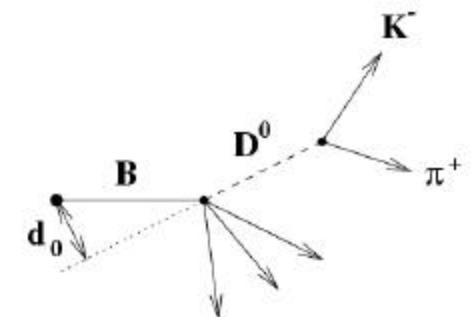
Direct Production

D points back to PV

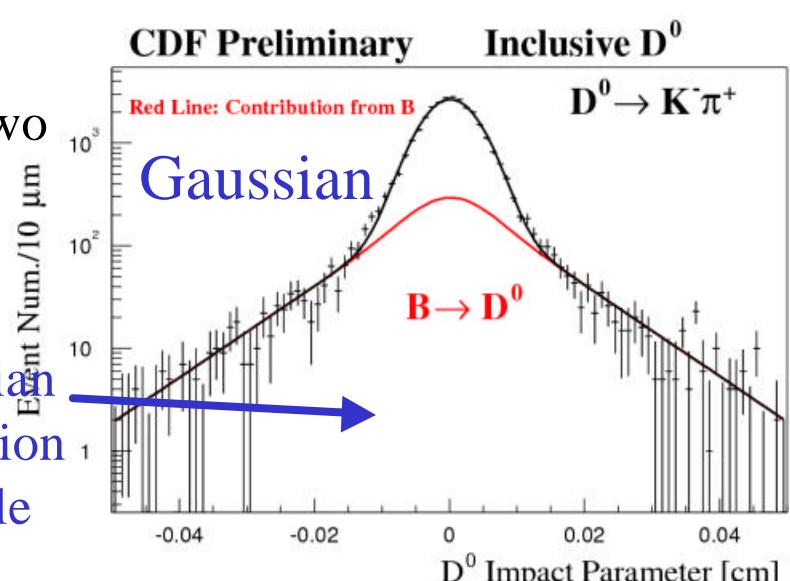


Secondary Production

D has finite impact parameter

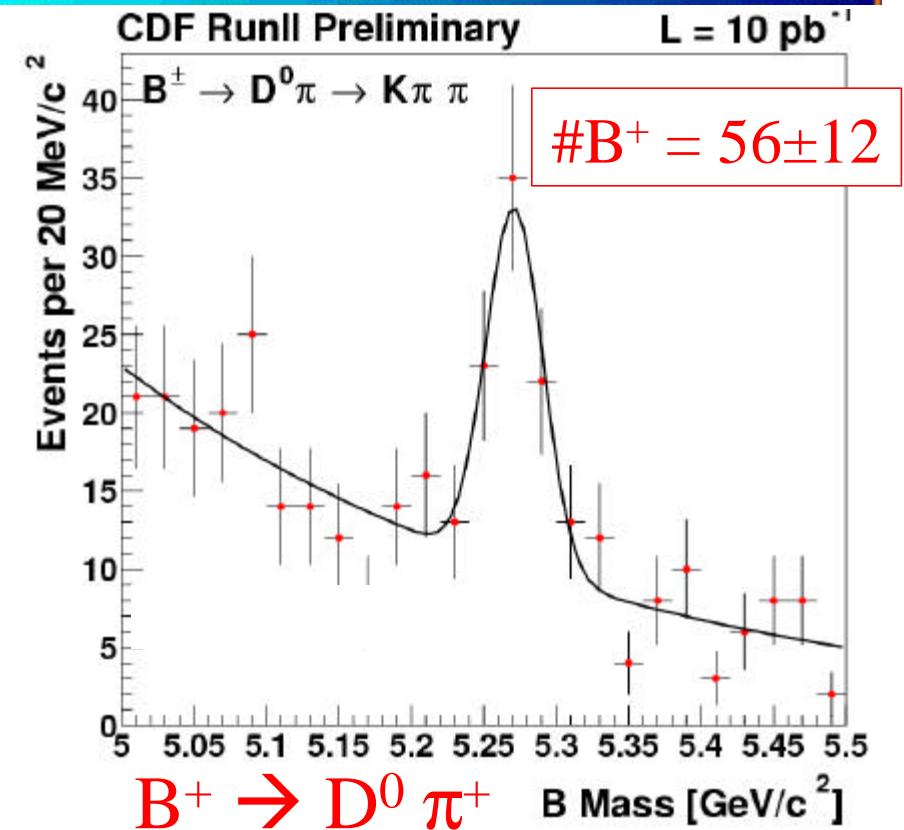
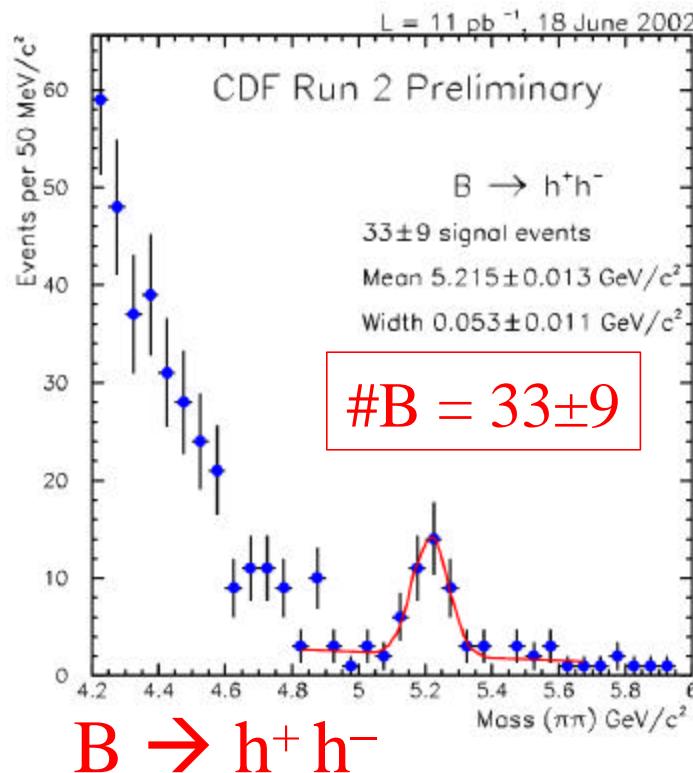


Range of fract.
from B using two
extreme
resolutions
functions:
- single gaussian
- parametrization
from K^0_S sample





Measurements with hadronic b triggers



❖ Hadronic B decays observed

- Yield lower than expected (silicon coverage/SVT efficiency > x 3)
- S/N better than expected
 - Better S/N dilution compensates reduced statistics



Conclusion

- ❖ The CDF detector is **fully functional** and accumulating proton anti-proton data
- ❖ Tevatron is moving toward reaching performance goals
- ❖ Understanding of detector is advanced
- ❖ Many early physics results
 - sometimes competitive in spite of limited statistics
- ❖ Ready to exploit full Tevatron potential as luminosity increases

CDF is back !

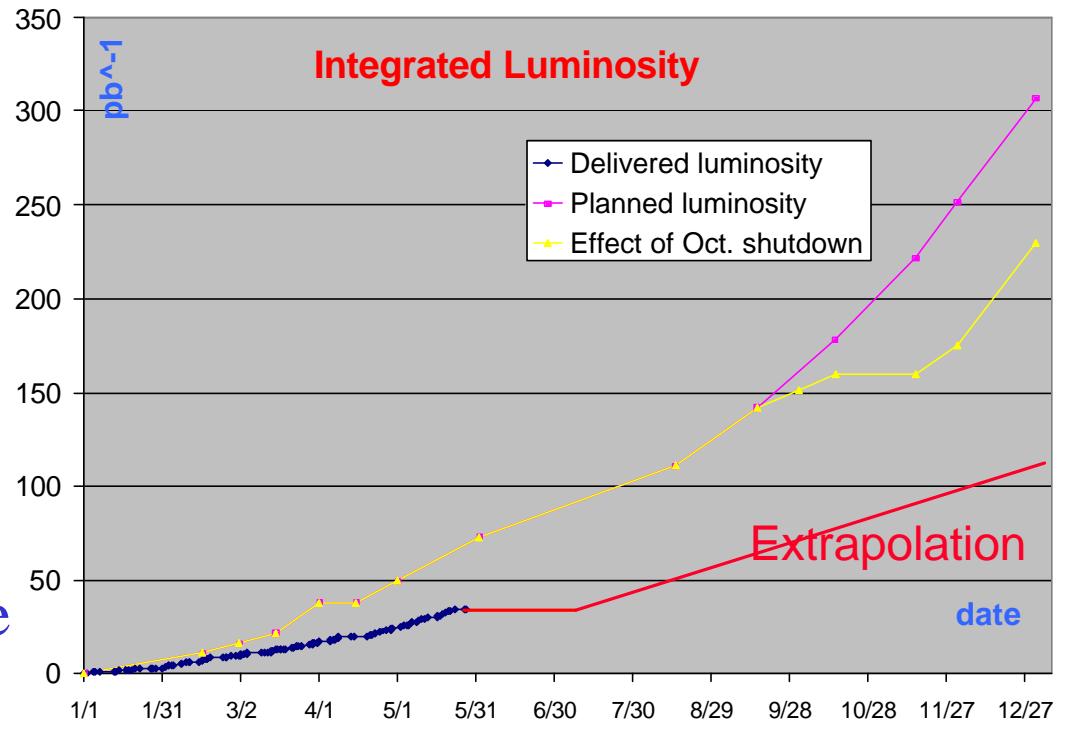


Backup slides

- Tevatron plans
- Silicon detector performance
- Trigger and DAQ details
- Data sample
- Talks in parallel sessions
- $Z \rightarrow ee$ FB asymmetry
- $W \rightarrow e\nu$ selection details
- $W \rightarrow \mu\nu$ details
- $W \rightarrow \tau\nu$
- MET resolution
- B mass plots
- B^+ lifetime
- Semileptonic B's
- Jet expectations
- Jet raw Et distributions

Tevatron status

- ❖ Short term plans:
 - Run until October
 - Reach goal w/o Recycler:
 - ◆ $5-8 \times 10^{31} \text{ cm}^{-2} \text{sec}^{-1}$
 - 1-2 months shutdown
 - Complete Recycler work
 - Commission and integrate Recycler during 2003
 - Mostly in parallel with Tevatron colliding beam operation

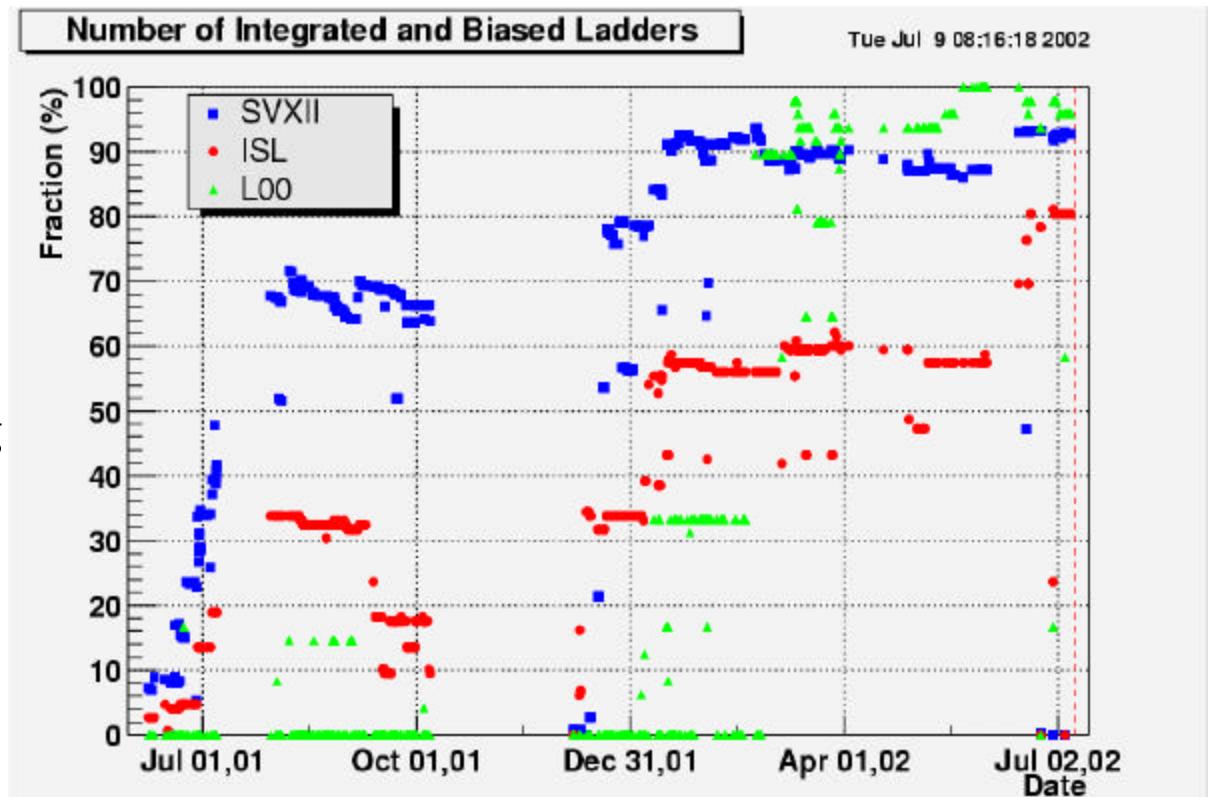
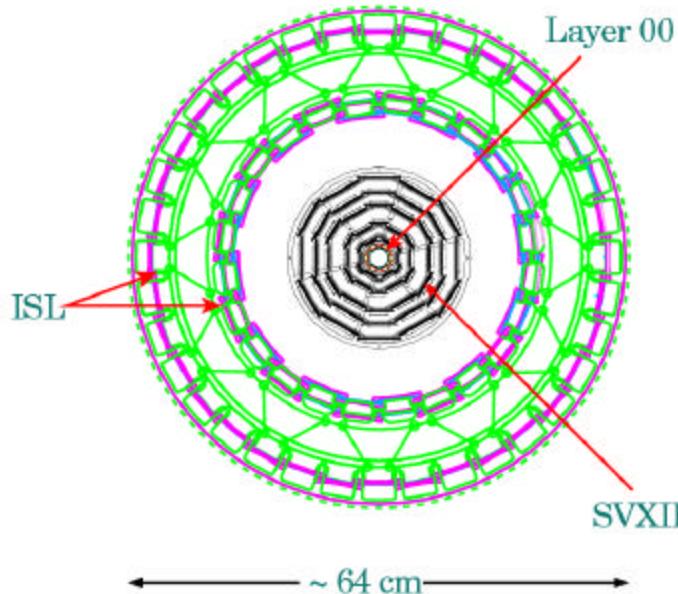


● Expect 100 – 200 pb⁻¹ delivered in 2002 ~ Run 1 data set

Detector Performance

❖ Commissioning:

- **L00** > 95%
- **SVXII** > 90%
- **ISL** > 80%
- Completing cooling work



% of silicon ladders powered and read-out by silicon system vs. time



Detector Performance

❖ Trigger:

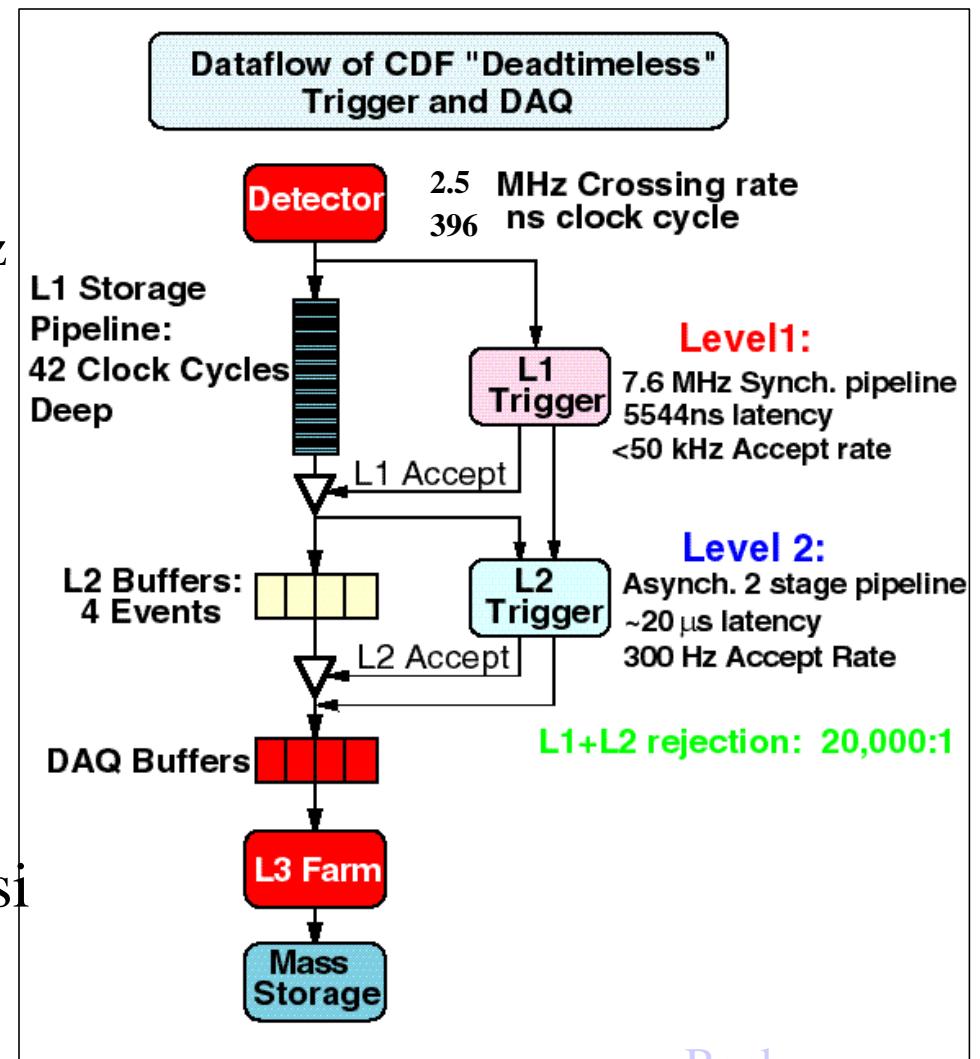
- Goal rates for $L = 2 \times 10^{32}$
 - $L_1/L_2/L_3 = 50,000/300/50$ Hz
- Typical now for $L \sim 10^{31}$
 - $L_1/L_2/L_3 = 6,000/240/30$ Hz

❖ DAQ

- Logging data at the planned rate of ~ 20 Mbyte/sec

❖ Offline:

- Data is reconstructed in quasi real time on a dedicated production farm



[Back](#)

[Back to index](#)



Data Sample

- ❖ Stable physics trigger table established since January '02

[Trigger/DAQ details](#)

- ❖ Summary of data used for this conference:

➤ Data period:	January – June, 2002
➤ Delivered luminosity:	33.0 pb^{-1}
➤ Live (to-tape):	23.5 pb^{-1}
➤ “Good runs”:	23.3 pb^{-1}
➤ “Good runs” with all systems	$\sim 10.0 \text{ pb}^{-1}$ (cfr. 110 pb^{-1} Run 1)
■ Radiation induced COT/SVX VME power supply failures (fixed!)	
■ Instabilities in Silicon readout (much improved)	

[Back](#)

[Back to index](#)



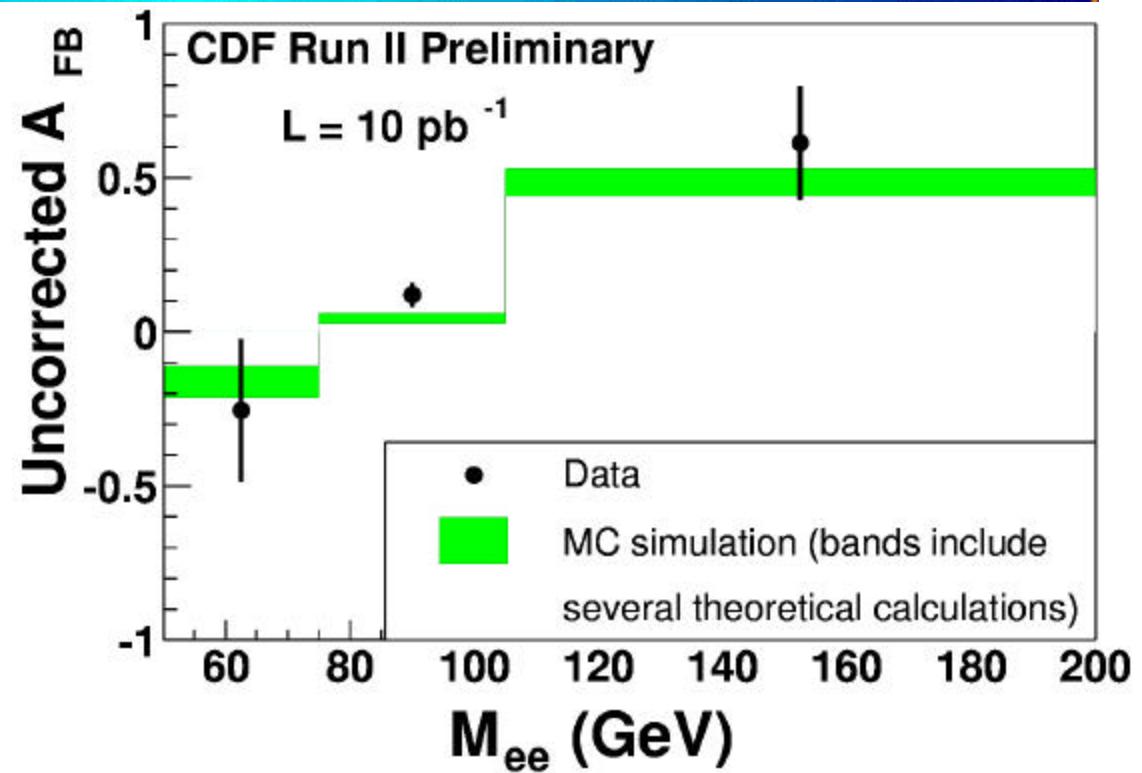
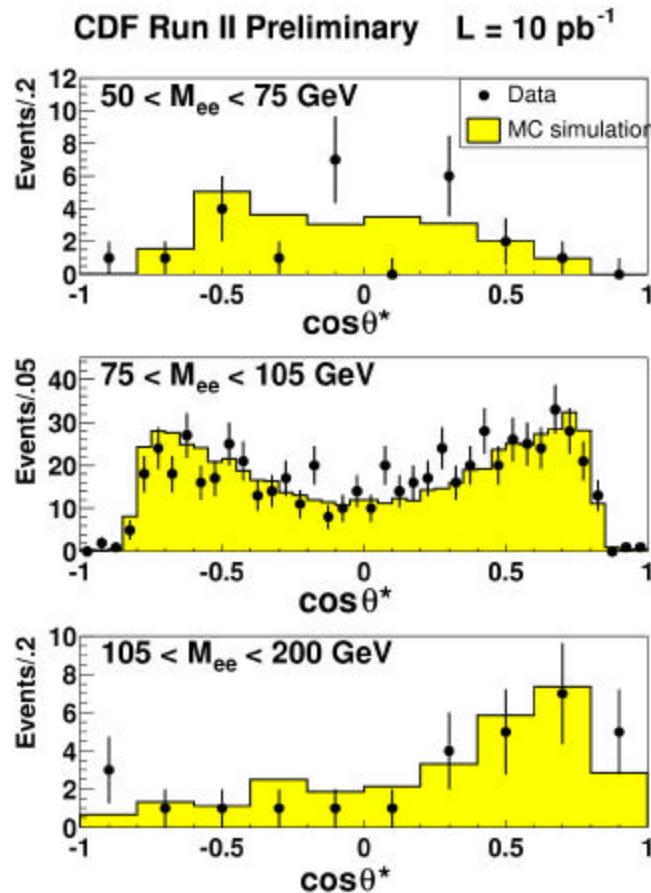
CDF-II results in parallel sessions

- ❖ Electroweak, session 4:
 - Prospects for EW physics in Run 2 (D. Glenzinski)
 - W boson cross section and decay properties (K. Bloom)
- ❖ QCD, session 5:
 - Jet and gamma physics (J. Dittmann)
 - Heavy Flavor at CDF (C. Paus)
- ❖ Heavy Quark, session 8:
 - First results with a hadronic trigger (A. Cerri)
- ❖ New Phenomena, session 10:
 - MSSM Higgs at the Tevatron (A. Connolly)
 - CHAMP searches (B. Orejudos)
- ❖ R&D, session 13:
 - Calorimetry (R. Erbacher)
 - Tracking (S. Nahn)



Measurements with high $E_T e^\pm$

- Uncorrected $Z \rightarrow e^+e^-$ angular distributions and asymmetries



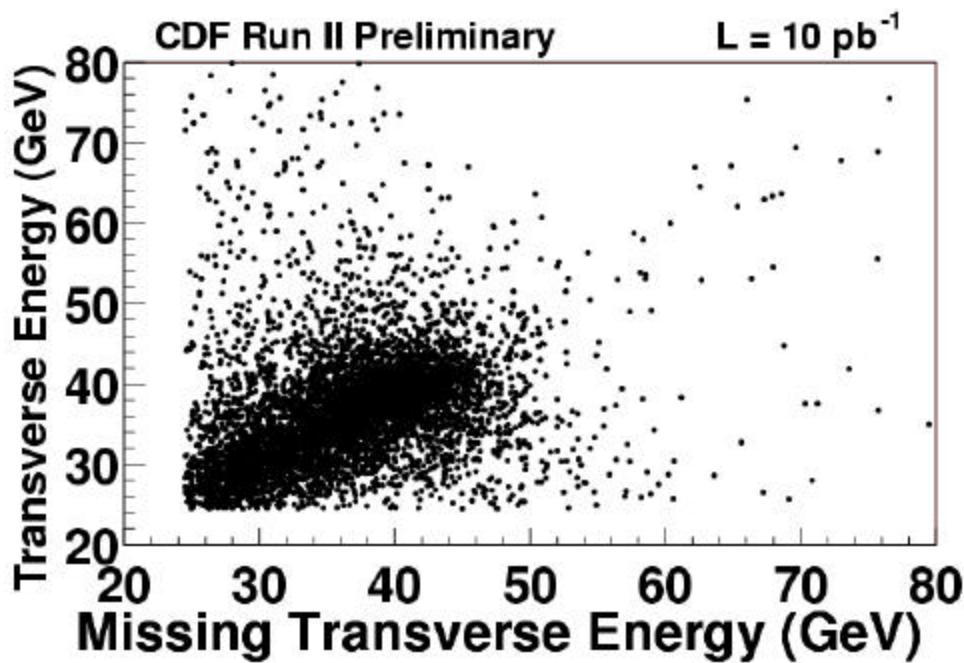
Measurements compared with Pythia/CTEQ5L prediction



Measurements with high $E_T e^\pm$

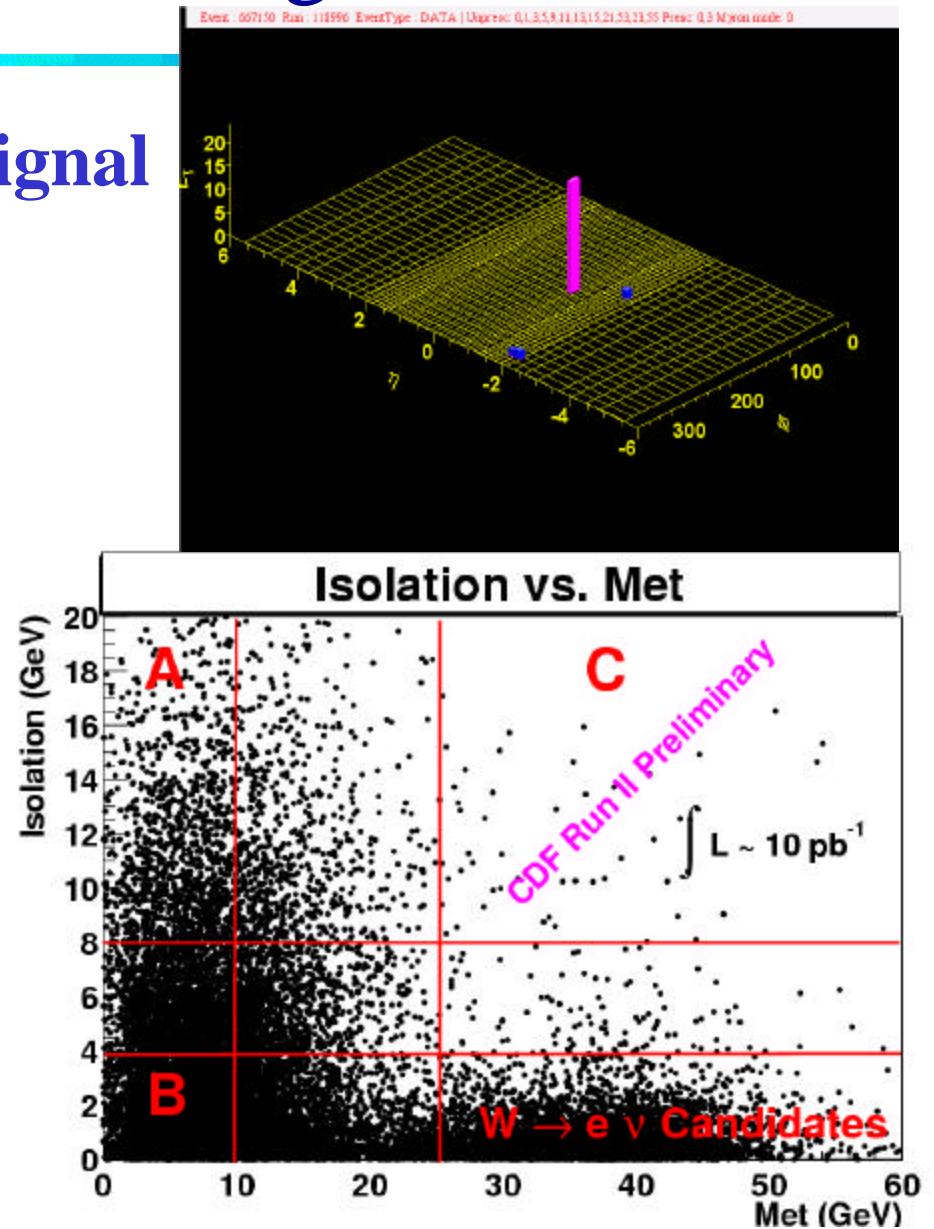
[Back](#)
[Back to index](#)

- ❖ Clear evidence for $W \rightarrow e\bar{\nu}$ signal
 - Isolated central electron
 - $E_T > 25 \text{ GeV}$, $\cancel{E}_T > 25 \text{ GeV}$



ICHEP 2002, Amsterdam

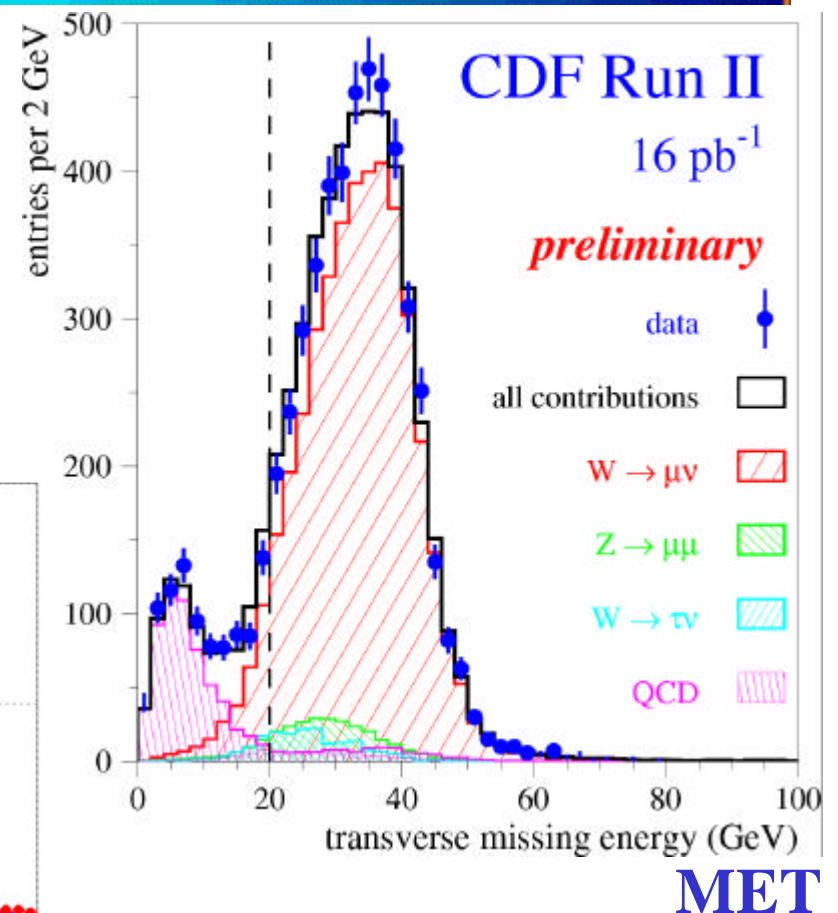
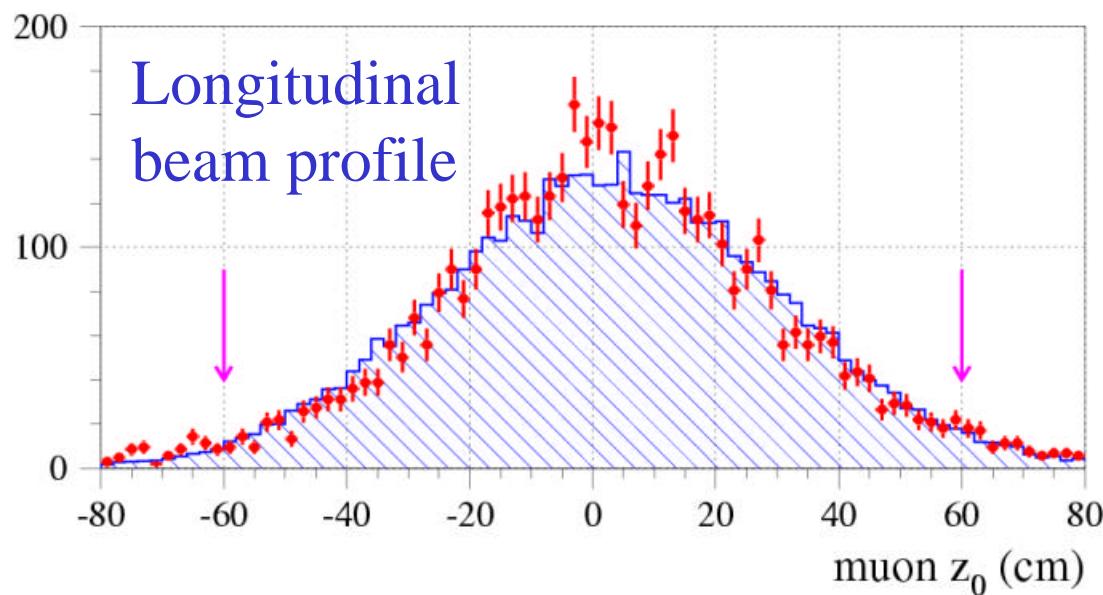
F. Bedeschi,





Measurements with high $E_T \mu^\pm$

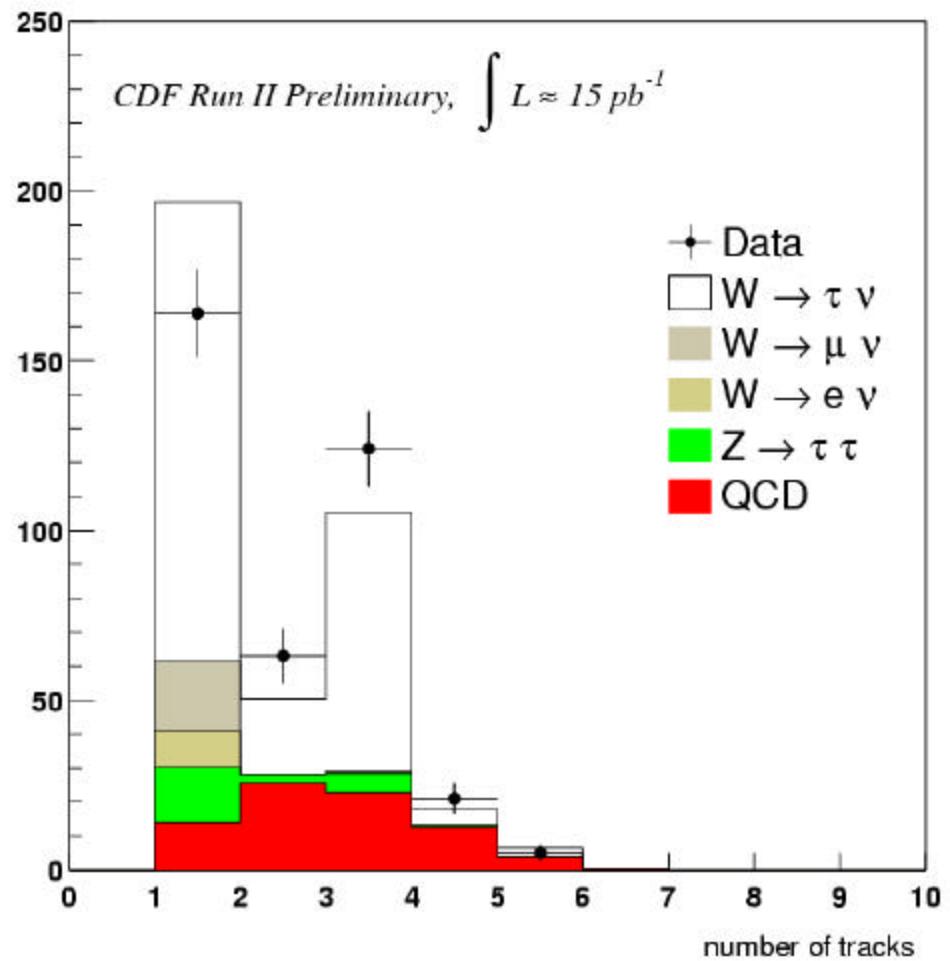
- ❖ Good modeling of observed $W \rightarrow mn$ distributions
- ❖ Measure $S(W \rightarrow mn)$ and $R = S(W \rightarrow mn)/S(Z \rightarrow mm)$



W → τ ν

- ❖ Evidence for typical τ decay multiplicity in W → τ ν selections

W → τ ν : number of tracks, associated with the τ candidate



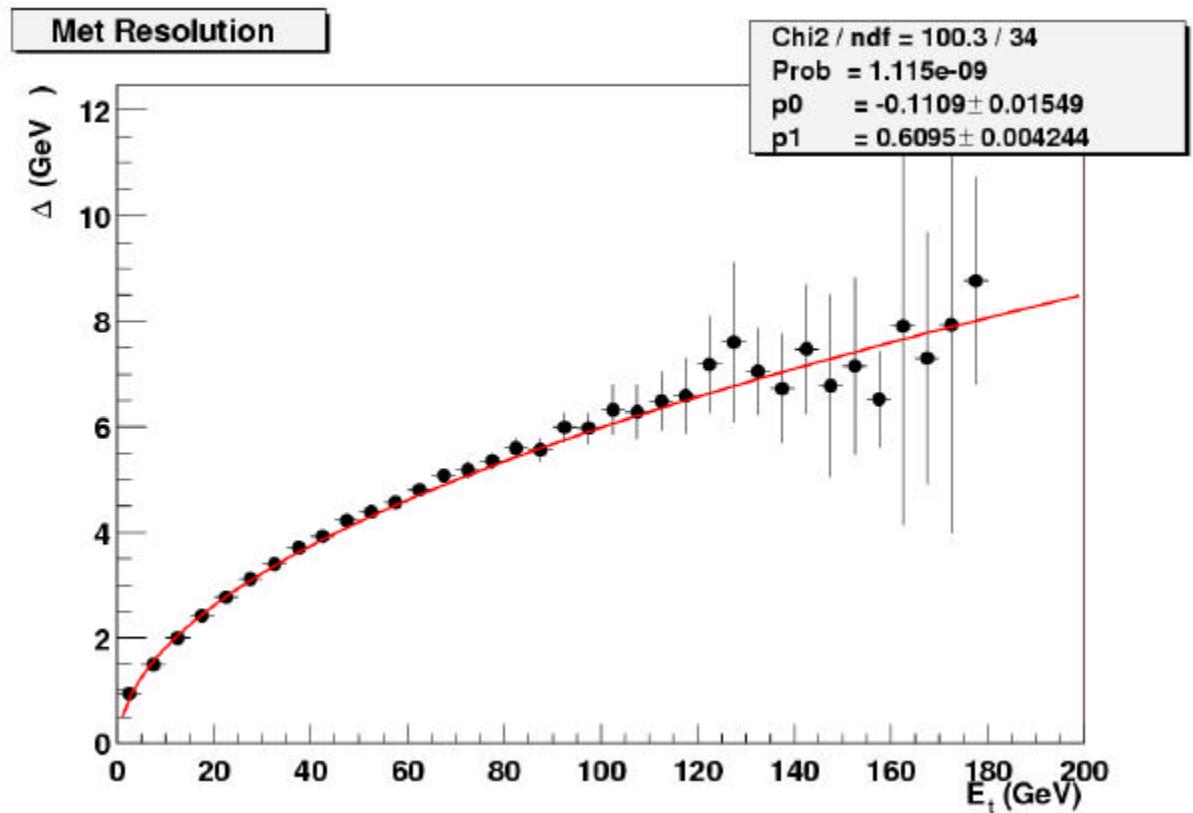
MET resolution

[Back](#)
[Back to index](#)

❖ Minimum bias events

- Run I: $0.53/\sqrt{\sum E_t}$ with forward cal. Use $|\eta|<4.2$
- Run II: $0.60/\sqrt{\sum E_t}$ with plug only $|\eta|<3.6$

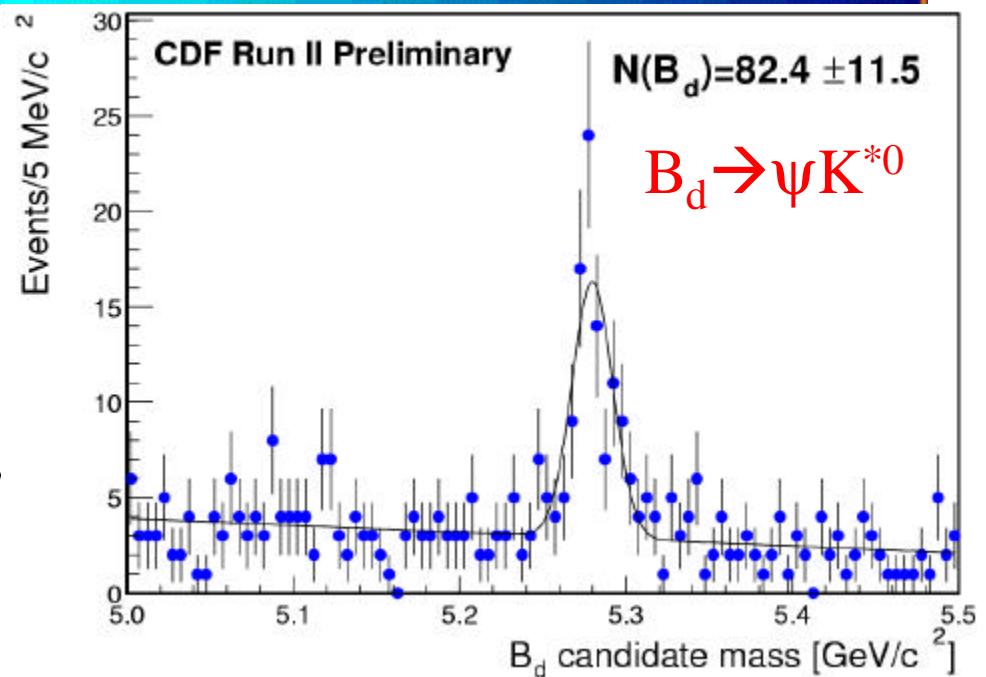
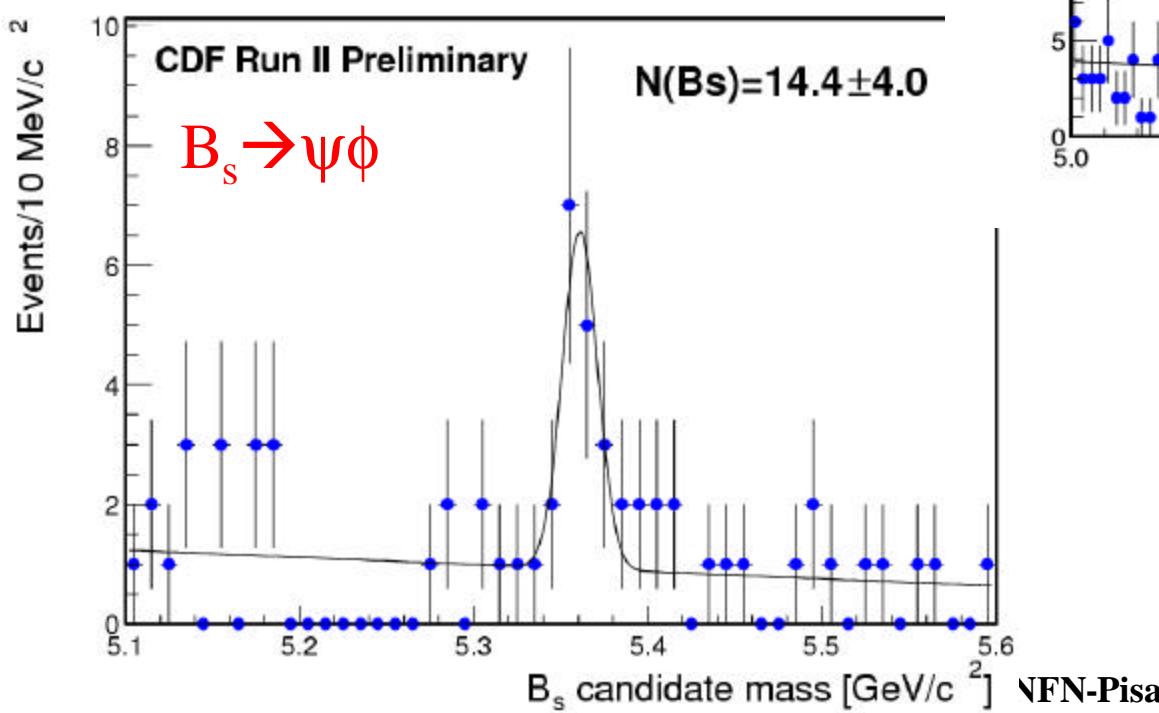
■ With miniplugin $|\eta|<5.5$





Measurements with low $\text{E}_T \mu^\pm$

- ❖ More mass plots:
 - B_d, B_s



[Back](#)
[Back to index](#)



Measurements with low Et μ^\pm

❖ B^+ lifetime:

➤ $B^+ \rightarrow J/\psi K^+$

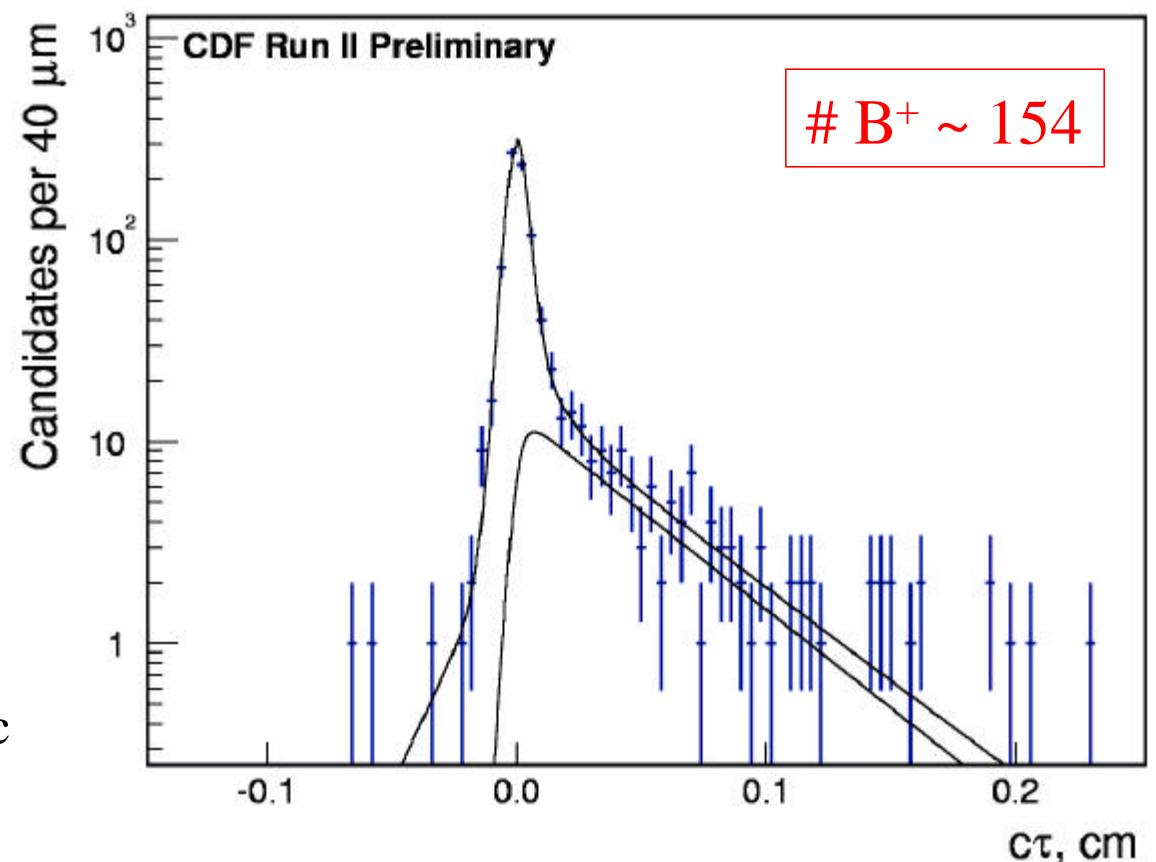
➤ Fit results:

■ $c\tau = 446 \pm 43 \pm 13 \text{ }\mu\text{m}$

($\Delta \text{PDG}/\sigma = 1.2$)

■ Res. scale factor 1.16

■ Conservative systematic
error

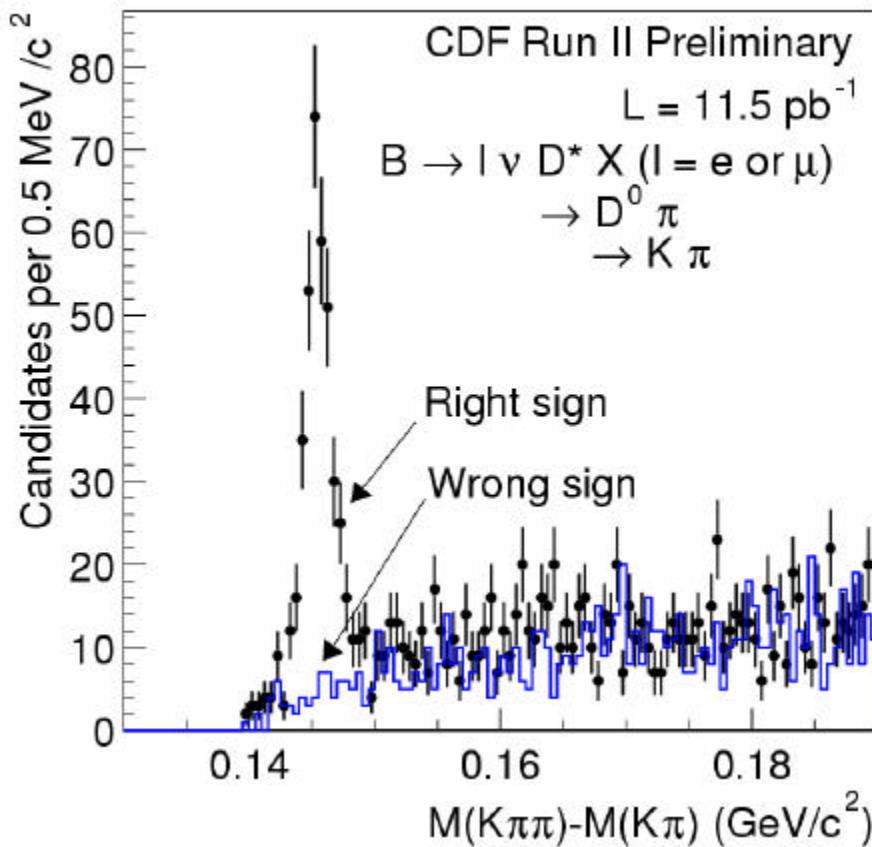




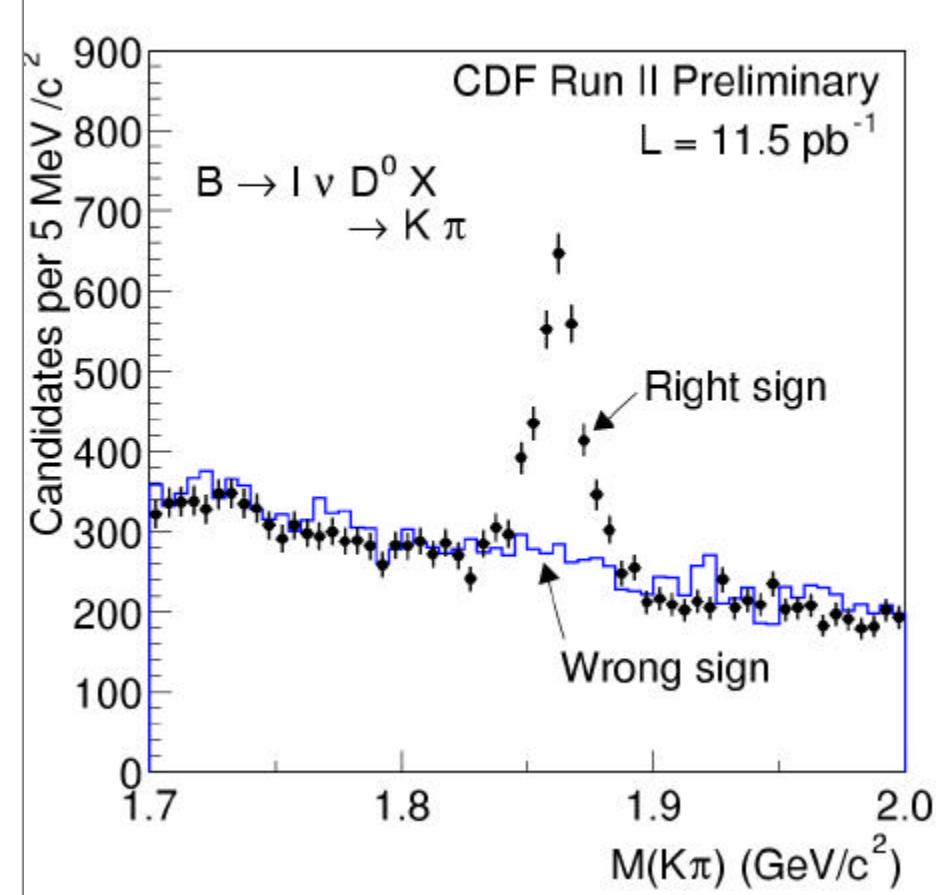
Measurements with inclusive leptons

- ❖ Find large samples of semileptonic B decays

[Back](#)
[Back to index](#)



ICHEP 2002, Amsterdam



F. Bedeschi, INFN-Pisa

Measurements with jets

[Back](#)
[Back to index](#)

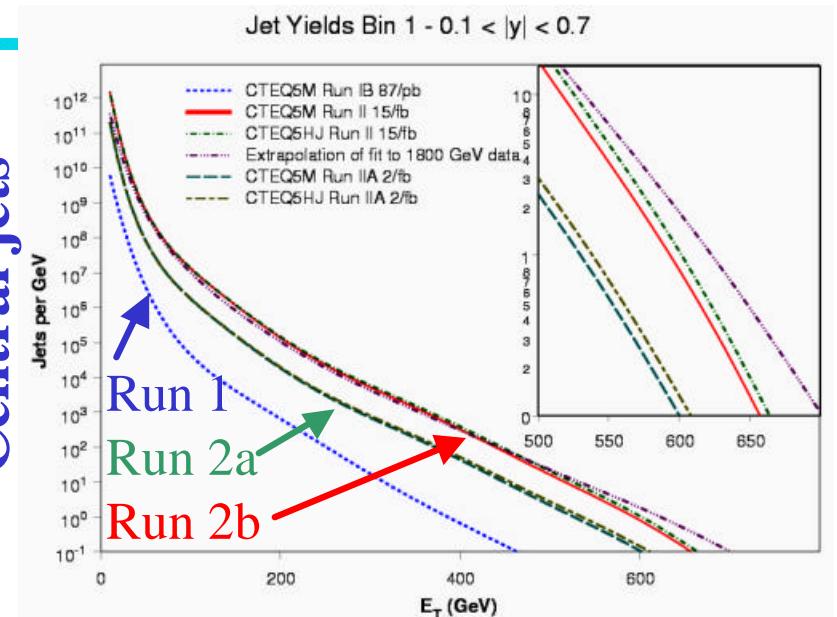
❖ Expectations:

- Increase max. energy reach
- Study both central and forward
 - New physics is mostly central
 - Pdf's affect both regions

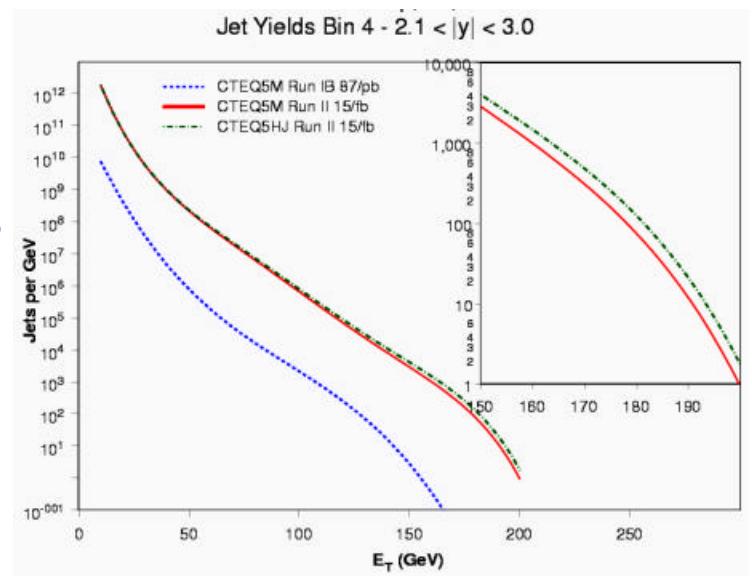
❖ Current work:

- Accumulate large samples
- Understand energy corrections
 - E-scale, jet shapes, MC tuning

Central jets

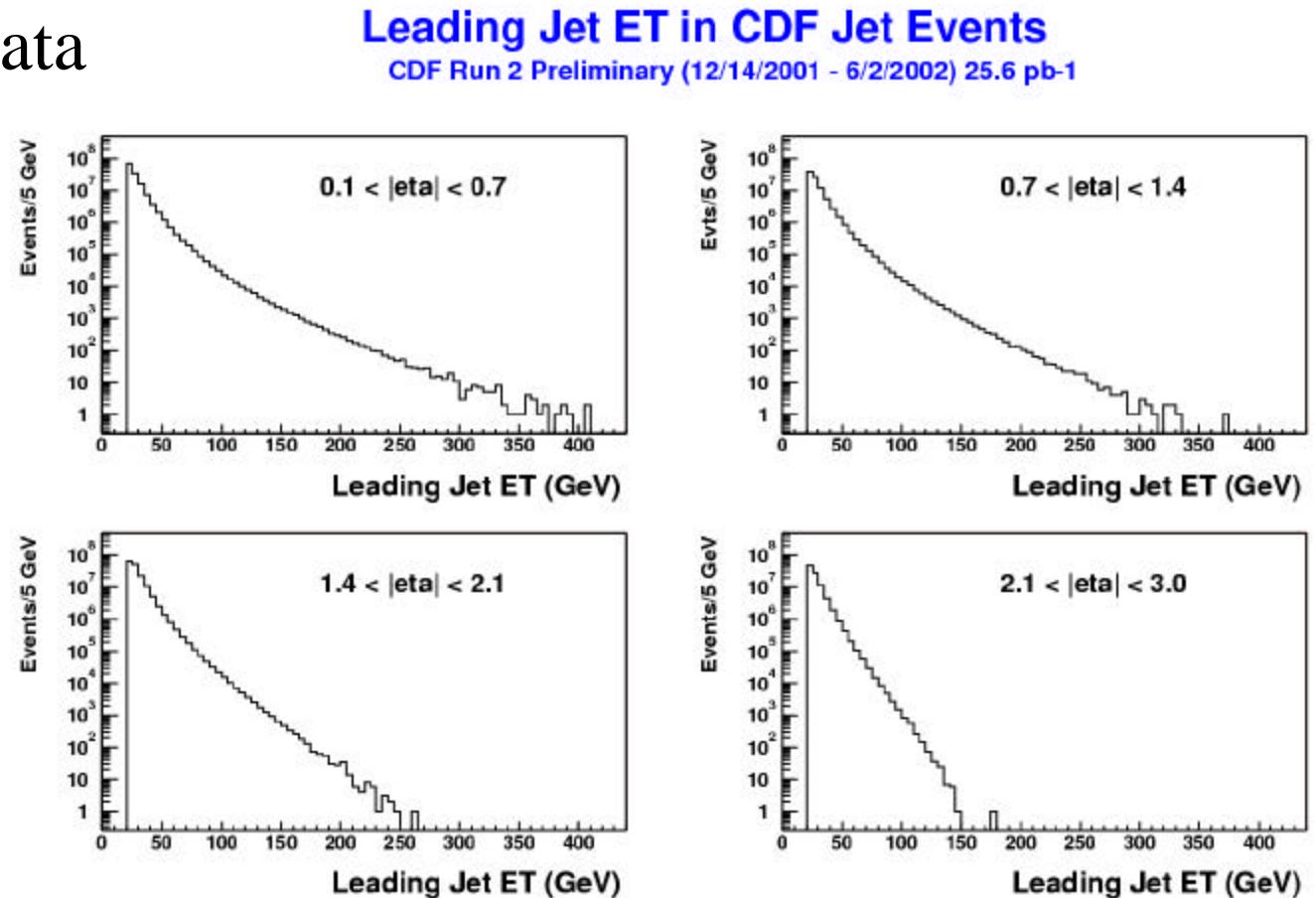


Forward jets



Measurements with jets

- ❖ Jet distr. from data
 - Raw E_T
 - Each trigger rescaled for pre-scale factor



Fixed cone algorithm: $R = 0.7$